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THE VOICE OF SCIENCE

ONCE more the burden of war is laid upon us. Once more, as in 1914, the cynical disregard of Germany for the rights of small nations has constrained the British people to take up arms in the cause of justice and fair dealing in international relations. The challenge of the German Reich has been accepted reluctantly, and with no illusions as to the nature of the glories of modern warfare, only after every effort to secure a peaceful but equitable settlement of the differences between Germany and Poland has failed. It has been accepted with full realization of the gravity of every implication of the decision. But in turning to war as the last resort, the British people has acted with a unanimity such as never before in its history, and with a grim determination that no effort shall be spared in the endeavour to ensure that the cause which it holds just shall prevail.

From 1914–18, the Allies opposed dynastic ambitions in the interests of the freedom of peoples. No longer were the people to be the pawns of the political intrigues of their rulers. The world, it was said, was to be made safe for democracy—words that now have a mocking ring. In 1939, the canker has sunk deeper. It is not merely political liberty that is at stake, though that too is jeopardized. It is the spirit of man.

In no previous war has science played so great a part as that which will be demanded of it in the struggle that is at hand. For a time, while the issue hangs in the balance, it is the duty of the man of science to lay aside his just misgivings whether the greatest force of the human intellect should thus be harnessed to the forces of destruction. For the moment, the interests of pure science as an intellectual pursuit and discipline must remain in abeyance. The energies, the abilities, and the knowledge of each and every individual with scientific training must be directed without remission to the service of the Allied cause. Nevertheless, the end to be attained, and the end which science should hold ceaselessly before the eyes of the Allied peoples, is not destruction, but a constructive ideal—to ensure in the future such conditions as will make possible the advancement of all the peoples of the world without discrimination, according to the status and the traditions of each, in the light shed by reason and scientific knowledge. To keep alive the aims of science in furthering the pursuit of truth in the universe and the relation of that truth to the developments of man's nature, without regard to tribal and racial distinctions, should be, indeed, must be, the ultimate function of the scientific thinker, whatever may be his more immediate preoccupations.

As to the form in which that ideal will find embodiment, at the moment, in the turmoil of initial operations, it is too soon to attempt a forecast; but that it is no idealist's dream is certain. The failure of the League of Nations as a political organization has cast discredit in the popular mind on such forms of international co-operation. Possibly the League of Nations came before its time, and this has obscured in the popular verdict the enormous value of its scientific work in the study of social and economic problems, and the progress which has followed, where the practical application of the solutions suggested has not conflicted with the trends of nationalist development. To extend the fields in which such co-operation between peoples may be applied is the task of the future, when the time comes, as it surely will, for reconstruction.

CENTRAL REGISTER OF SPECIALISTS

IN NATURE of April 8, reference was made to the formation by the Ministry of Labour, for war-time use, of a central register of those with scientific, technical and professional qualifications, and the scheme was recommended to the attention of our readers. The need has now arisen, but fortunately the Register has reached an advanced stage, due to helpful co-operation of a great many learned bodies and professional institutes, and the Committees of the Council which advises the Minister on the Register have been reviewing the position reached.

We are informed that, at the end of July, 86,000 names were on the Register as a whole; the scientific research part of the Register contained at that date 7,000 names. The cards completed by the volunteers are held at the Ministry of Labour classified under the scheme of classification approved by the Committees, and a duplicate set of cards in the research classifications is held by the Royal Society.

The immediate purpose of the Register, which is under the guidance of the Advisory Council and its Committees, is to meet demands in war-time for the services of scientific and other personnel made by Government Departments (who will draw upon the Central Register for all their demands for persons possessing these qualifications) and by other employers engaged on work of national importance. Enrolment is voluntary, as indeed is the whole scheme. The services of panels of the Committees of the Council will be available for the selection of candidates for submission to the posts offered. In making the submissions, regard will be paid to the importance of the work offered in relation to that on which the volunteer is already engaged. The question of remuneration will be a matter for settlement between the volunteer and the employer concerned.

The Register will be operated centrally, but in the event of war exigencies compelling regional operation in any area, regional panels, nominated by the Committees, will act on their behalf.

How far those enrolled on the Register will be called upon can only be a matter of conjecture, and no promise is given that any particular individual will, in fact, be required. Those enrolled on the Register need not be deterred from undertaking any of the forms of national service (consistent with the Schedule of Reserved Occupations), but where such undertakings will involve full-time service they are asked to notify the Central Register.

There can be no question that, in the war which is now on us, a great demand will arise for the resources of scientific knowledge available for defence, and this section of the Register constitutes an extremely useful part of the general organization which the Government has set up for national defence.

A separate register of teams of scientific workers which it may be desirable to keep intact during at least the earlier stages of war has been compiled by the Department of Scientific and Industrial Research, and close liaison is naturally being maintained between this register and the Central Register.

The section of the Register relating to scientific research is dealt with by the Scientific Research Committee of the Council, with Prof. A. V. Hill, one of the Secretaries of the Royal Society, as its chairman, and is made up as follows: Prof. C. G. Darwin (mathematics), Dr. E. V. Appleton (physics), Prof. J. C. Philip (chemistry), Prof. R. V. Southwell (engineering science), Dr. E. B. Bailey (geology), Prof. V. H. Blackman (botany), Prof. D. M. S. Watson (zoology), Prof. A. V. Hill (physiology), Prof. W. W. C. Topley (pathology), Prof. F. C. Bartlett (psychology), Mr. C. S. Wright (director of scientific research, Admiralty), Dr. H. J. Gough (director of scientific research, War Office), Dr. D. R. Pye (director of scientific research, Air Ministry), Dr. R. E. Stradling (director of scientific research, Home Office), Dr. A. Landsborough Thomson (Medical Research Council), Sir E. J. Butler (Agricultural Research Council.)

The Committee has the following sub-committees: (1) Bacteriology and Pathology, (2) Botany, (3) Chemistry, (4) Engineering Science, (5) Geology, (6) Mathematics. (7) Physics, (8) Physiology and Biochemistry (9) Psychology, (10) Zoology.

The method of compiling this section has already been explained in the article in NATURE referred to above. The response to the appeal made for volunteers has been the best of any section, and

is extremely gratifying. The proportion of those qualified scientific research workers approached by the Royal Society who have offered their services in their professional capacity for work of national importance in the event of war was already, at the end of July, 88 per cent.; it is now greater.

The Committee with its Sub-Committees has made recommendations regarding the Schedule of Reserved Occupations as affecting science. It has also directed attention to the need for facilitating the entry of suitable scientific workers into special branches of the defence forces.

The cards of the volunteers in the ten sub-sections of this section of the Register have been carefully reviewed by the sub-committees with a view to the best possible use being made in war of the special qualifications and experience of each individual. A certain number of research workers within the various categories were earmarked, before war broke out, for service with research branches of the defence departments.

The Committee had placed great importance on the preliminary training of research workers for war work, and the defence departments are arranged this summer for preliminary instruction at experimental stations, etc., of volunteers.

In view of the prominent part which industrial chemistry will be called upon to play in war-time, reference may be made to the Industrial Chemistry Section of the Register. The Committee advising on this Section of the Register has as its chairman Prof. J. C. Philip, and its members are as follows: Dr. W. A. S. Calder, Dr. W. Cullen, Mr. J. Davidson-Pratt, Dr. L. H. Lampitt, Sir Gilbert Morgan, Sir Robert Pickard, Dr. R. E. Slade.

As a result of the Committee's recommendation the leading chemical societies and related bodies had invited their members to volunteer for the Register. The Association of British Chemical Manufacturers had also, with the Committee's approval, approached its employer members asking them to encourage qualified members of their staffs who are not in membership of one or other of the co-operating technical bodies to apply for inclusion in the Register. It is, of course, still open for any individuals not members of the associations mentioned, who are qualified by training and/or experience, to volunteer by communicating directly with the Central Register Branch, National Service Department, Ministry of Labour, Montagu House, Whitehall, S.W.1.

The Industrial Chemistry Committee also has been studying in greater detail the cards filed in the various sub-sections of the industrial chemistry classification, and, apart from certain necessary adjustments as between this section and the section for research chemists, it is proposed to consider the steps which should be taken to supplement those sub-sections where the present number appears to be inadequate in relation to war-time demands.

The number of volunteers enrolled in this section was 4,985, at the end of July. While this result is regarded as moderately satisfactory, it is understood that there has been reluctance on the part of some employers to allow qualified members of their staff to enrol. This may be due to a misconception of the use to which the Register will be put in war-time. The selection of persons for submission to posts will be made by experts in the particular field, working within the general scheme of priorities laid down by the Government.

Further, before volunteers already in employment are submitted for alternative posts the observations of their existing employers will be carefully considered by expert committees appointed for the purpose. It is therefore hoped that in the national interest employers will encourage their qualified staffs to enrol on the Register, so that it may be equal to the calls made upon it. It is to be remembered also that the Register will be available for the use of employers as well as of Government Departments, and that in certain circumstances they may find it of great use for securing replacements of staff.

Reference has been made above to two only of the several sections of the Central Register of Specialists, namely, scientific research and industrial chemistry, the detailed working of which will be of special interest to readers of NATURE. The complete register covers every aspect of professional and intellectual activity of a modern civilized State. The whole conception is an eminently scientific undertaking, approached in a scientific manner with full consideration of all the pitfalls of which the experience of the war of 1914–18 made the community aware. However much we may deplore the circumstances through which the Central Register has arisen, it should be welcomed as an invaluable record of the scientific and learned life of Great Britain which will prove of inestimable service now and in happier times when reconstruction begins.

STANDARDS OF PHYSICAL MEASUREMENT

National Physical Laboratory Collected Researches

Vol. 24: Standards. Pp. iii + 450 + 19 plates. (London: H.M. Stationery Office, 1938.) 22*s*. 6*d*. net.

STANDARDS provide the foundation for the intelligent co-ordination of all physical measurements. The refinement with which this co-ordination may be carried out rests fundamentally upon the precision with which the values of these standards are known and the extent to which they are utilized by research men in expressing their experimental results. The present volume of ten papers on standards shows the fidelity with which the National Physical Laboratory is carrying out its functions in establishing standards of measurement worthy of the name.

Electrical Measurements. The 'International' system of electrical units was adopted by the International Electrical Congress held in Chicago in 1893. Great difficulty was later encountered in establishing precise standards on the basis of the mercury ohm and the silver voltameter. The situation was temporarily met in 1910 through a joint decision of the standardizing laboratories of the leading nations to adopt consistent values for their standard resistances and standard cells, based on an intercomparison of their national standards. But some of these national standards began to drift, and the temporary uniformity was lost. Furthermore, it was soon recognized that the 'International System' departed by several parts in 10,000 from the absolute system of electrical units.

In 1929, the International Committee on Weights and Measures requested the various national laboratories to undertake the establishment of the electrical units in absolute measure. Two of the papers in the volume under review represent the contribution of the National Physical Laboratory to this undertaking.

The first of these deals with Vigoureux's absolute determination of the ampere. The current balance used in earlier work at the National Physical Laboratory was modified for this purpose, the most important change being the construction of new coils. Numerous measurements led to the conclusion that the unit of current at the National Physical Laboratory as realized by means of resistance coils and standard cells is 14 ± 3 parts in 100,000 less than the absolute ampere.

The accuracy of this result is believed by Vigoureux to be affected mainly by (1) systematic errors, (2) want of exact knowledge of the linear dimensions of the coils and (3) uncertainty in the absolute value of the local acceleration of gravity, which was derived from the Potsdam measurements. It may be stated parenthetically that recent absolute measurements of g both at the National Physical Laboratory and at the National Bureau of Standards give values slightly less than the classical Potsdam determinations.

A second paper by Vigoureux deals with the absolute determination of the ohm by the method of Lorenz. The Lorenz machine erected at the National Physical Laboratory in 1912 was used in this work, but new apparatus was constructed for adjusting the four inductance coils coaxially with the shaft and for determining the distance between the coils. The dimensions of the coils were also re-measured. The results showed that the National Physical Laboratory 'International' unit of resistance exceeds the absolute ohm by 50 ± 3 parts in 100,000.

Two other electrical papers appearing in the volume afford significant examples of international co-operation. "The Capacitance and Power Factor of a Mica Capacitor" is a joint contribution of Curtis and Sparks of the National Bureau of Standards and Hartshorn and Astbury of the National Physical Laboratory. Two radically different methods were used. At the National Bureau of Standards the mica capacitor was compared by alternating current with an air capacitor, the capacitance of which can be evaluated in terms of resistance and time. At the National Physical Laboratory the comparison was made by means of alternating current with a mutual inductance, which can be evaluated from its dimensions. The two methods gave results in agreement within 1 or 2 parts in 10,000, which is about the accuracy of the measurements.

The "International Determination of the E.M.F. of the Normal Weston Cell in International Volts" by Vigoureux likewise gives the results of a joint investigation by the Physikalisch-Technischen Reichsanstalt, National Physical Laboratory and National Bureau of Standards. The final value was 1·0183 volts at 20° C., which confirms the recommendations of the International Technical Committee in 1910.

A paper by Davis, Bowdler and Standring deals with the difficult problem of measuring peak voltages. Two methods were employed: (1) The voltage on the low-voltage arm of a condenser-divider was rectified. (2) The current through a condenser connected across the voltage to be measured was rectified and the mean current used

as a measure of the peak voltage. Agreement to 2 parts in 1,000 was obtained.

The Thermometric Scale. A temperature between 0° C. and 100° C. on the 'International Temperature Scale' is evaluated by means of the platinum resistance thermometer. In his paper on this subject, Hall compares the platinum scale with the earlier N.P.L. scale maintained by mercury in verre dur thermometers. He found differences as large as 0·02° C. between individual mercury thermometers, but for selected thermometers the change to the platinum scale did not change the N.P.L. scale more than 0·002° between 0° C. and 50° or more than 0·005° between 50° C. and 100° C.

Another example of international team-work is to be found in the paper "International Comparison of Temperature Scales between 660° C. and 1063° C." by Roeser of the N.B.S., Schofield of the N.P.L. and Moser of the P.T.R. After exchanging thermocouples and samples of silver, the temperature scales of the three laboratories were brought into agreement within 0·1° C. at all points in the range covered.

Metrology. Stott's investigation of pivots and jewels as used in instruments and meters is an outstanding contribution to this subject. It covers the production of accurately shaped pivots, deformation under loading, friction, wear and lubrication. The paper should be studied by everyone who uses pivots and jewels in fine instrument design.

Under the title "Determinations of the Fundamental Standard of Length in Terms of Wave-Lengths of Light", Sears and Barrell present the results of their precise measurements in this field. An accompanying paper describes the apparatus. Their determination of the metre in wave-lengths of the red radiation of cadmium is in good agreement with the results of other observers. In fact the mean of all these determinations is practically identical with the value obtained by Benoît, Fabry and Perot, upon which all modern spectroscopic wave-length tables are based. The authors wisely urge that this relationship be preserved in any future definition of the unit of length in terms of wave-lengths of light.

Sears and Barrell also carried out for the first time a direct determination of the length of the Imperial yard in terms of wave-lengths of the red radiation of cadmium, from which the ratio of the yard to the metre may be derived. They direct attention to the advantage of re-defining the yard in terms of light-waves so chosen in number that 1 inch = 25·4 mm. or 1 yard = 0·9144 metre, exactly. This simple factor represents closely the mean between the present yard of Great Britain and that of the United States. Its official adoption would involve a change of not more than two parts in a million by either nation. It would not disturb industry in the slightest, because as a matter of fact this ratio has been in industrial use in both countries for many years. The National Bureau of Standards is in hearty accord with this proposal.

LYMAN J. BRIGGS.

BUILDING RECOMMENDATIONS

Principles of Modern Building

Vol. 1: Walls, Partitions and Chimneys (Department of Scientific and Industrial Research). By R. Fitzmaurice. Pp. 400+20 plates. (London: H.M. Stationery Office, 1938.) 10*s.* 6*d.* net.

ONE of the principal functions of the staff engaged at the Building Research Station, Garston, is to provide answers to the numerous inquiries received from all branches of the industry. These have led to the examination of building practice from every possible point of view, and this volume, compiled by the member of the staff responsible for dealing with these inquiries, contains information which has been collated from an experience unique in its extent and in its authoritativeness. This volume deals only with walls, partitions and chimneys, and is the first of a series the preparation of which has been undertaken at the joint request of the Royal Institute of British Architects and the Chartered Surveyors' Institution. It represents also the first fruits of a suggestion contained in the interim report of the Ministry of Health Committee on the Construction of Flats for the Working Classes.

Here is no mere recapitulation of established method and practice. The aim has been to formulate a statement of the functions of a building, as these are now understood, and the elements in its composition, and thus to guide the practical man in adapting his work to meet present-day requirements. Such problems as those of obviating dampness in walls, of avoiding smoky chimneys, and of providing insulation against the penetration of sound are representative of the useful points discussed. Of special value are the sections which deal with load-bearing walls both of the solid and of the cavity types and those in which new or

recently introduced materials are discussed. An outstanding feature of the book is the concise, clear manner in which practical recommendations are given.

The necessity for such an authoritative series of volumes of reference can be understood when it is remembered that, until recently, building practice was subject only to very gradual changes. The rapid developments of modern times have led to the introduction of a multitude of innovations, some of which can be described as ill-advised. In showing the designs and methods which have been closely scrutinized and finally approved at the Building Research Station, this volume can be seen to be an invaluable contribution to the formulation of a code of good practice. It has been attractively prepared, is profusely illustrated with photographs, drawings and graphs, and is supplemented by lists of references and of appropriate British Standard Specifications.

THE CALIFORNIAN DESERTS

(1) The Californian Deserts:
a Visitor's Handbook. By Edmund C. Jaeger; with Chapters by S. Stillman Berry and Malcolm J. Rogers. Revised edition. Pp. x+209. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1938.) 9*s*. net.

(2) Deserts
By Dr. Gayle Pickwell. (Whittlesey House Publication.) Pp. xiv+174 (64 plates). (New York and London: McGraw-Hill Book Co., Inc., 1939.) 15*s*.

(1) HERE is a model guide-book, for its presentation is artistic, its facts correct and well chosen and the deductions therefrom modern. A desert is a place of high summer temperatures with steady, drying winds and a rainfall not exceeding five inches; these are usually accompanied by a high, diurnal temperature range, here about 40° F. There are complications, for the rain-carrying winds rise in the Gulf of California, cross mountains and descend in occasional bursts on a dissected, mountainous land, extending from the Colorado River for two hundred miles along the inland half of California. The possible evaporation appears to be 80–100 inches, so that the intensity of the aridity is considerable. These conditions have only been reached since the end of the Pleistocene, and there would appear to have been several periods of wetness. To the south the fertile belt of the Colorado separates the similar desert of Arizona and Sonora (Mexico), and there have always been in both deserts lake and other areas of permanent water such as the famous 'Death's Head Valley' and the 'Salton Sea' in California.

Comparisons with Old World deserts are impossible, for here are more than seven hundred species of plants. Many are supposedly desert-adapted, but caution is advised, since marsh and bog plants, owing to an absence of nitrogen, may show similar changes. Some of the peculiar races are doubtless evolutions of northern plants, but there has probably been extensive immigration from the high, more ancient desert-lands of Sonora.

Insects are a function of plant-growth, so that there must be several thousand species, mostly living in inconspicuous habitats; the most visible are treated of in an interesting chapter. Snails and higher animals are well considered, the whole leading to a naturalist's account of the mammals, which are represented by thirty-six genera, including beavers which have given up the dam-making habit. The preservation of the bighorn sheep, of which about 600 are left, is immediately important, since experience has shown that the area occupied by a wild race of sheep which has been destroyed cannot be readily repeopled by sheep from other areas.

The Californian deserts are laboratories, conveniently situated for study; the experimental research is that of Nature, the lines those of past times, and hence peculiarly suited to the study of the changes which are due to natural evolution.

(2) Dr. Pickwell in his turn provides 64 full-plate photographic illustrations of these same deserts. His text for the most part is explanatory of these, to which is often added original observations on the biology of some of the plants and animals pictured. Unfortunately, many of the reproductions appear rather black-and-white so that frequently where detail is needed in the plants, it cannot be found. My own experience in similar landscape photography in the tropics leads me to suggest that for plants and forests a side light with consequent low-toned shadows is desirable, my practice being to close the camera for the six hours of midday. A concluding chapter summarizes the desert features and problems, subjects upon which experimental researches are urgently required, especially in respect to the water requirements of animals.

J. S. GARDINER.

INSTRUMENTS IN SCIENCE AND INDUSTRY*

By Robert S. Whipple

I FEEL that it is a great honour to be chosen as president of Section A of the British Association, particularly because on looking through the names of my distinguished predecessors I find that I am the first professional maker of scientific instruments to occupy this chair. My immediate predecessor, Dr. C. G. Darwin, who now occupies the important position of director of the National Physical Laboratory, gave us at Cambridge a brilliant dissertation on the use of mathematics in solving physical problems, and the need of the mathematical outlook when facing a series of facts requiring solution. He would, I am sure, be one of the first to insist that the mathematician requires physical facts to enable him to develop a physical theory, and that the probable soundness of the theory will depend largely upon the accuracy of the data discussed. In the majority of cases this accuracy depends on the qualities of the apparatus employed in the observations, assuming that the observer is fully qualified and capable of obtaining the best results from it. I believe that all such observers now demand far more from their apparatus than was formerly possible, but few realize the amount of thought and labour involved in raising the accuracy obtainable from one to one-tenth of one per cent.

The help that instruments have given to the advancement of science is a fascinating theme, and at the same time a wide one. Among the earliest and most striking examples we find that Kepler was able to state his laws of planetary motion as a result of the observations made with Tycho Brahe's carefully constructed instruments. Tycho (1546–1601) first introduced (though he did not discover) the method of transversal division of the arc, which is now familiar to us as the basis of the diagonal scale. It was he who first pointed out the importance of symmetry in an instrument. The ingenious naked-eye sights developed by him were a remarkable improvement on the simple sights previously used. According to Dreyer, his determinations of the right ascensions and declinations of his nine standard stars show a probable error of less than thirty seconds of arc—an almost incredible achievement.

I propose to consider a few well-known instruments and to use them as examples to indicate how the development of a particular subject has grown largely with the perfection of the instruments used to investigate it. It is in every way a reciprocal process. By means of an instrument certain evidence is obtained; this evidence does not go far enough and the instrument must be improved to enable further facts to be found. If, for example, the biologist requires to examine small bodies beyond the range of his microscope, he appeals to the physicist to help him, and the appeal is not in vain. Most probably, as a result of the work on his colleague's problem, the physicist develops a technique which will be of service to him or to a fellow-physicist.

* From the presidential address to Section A (Mathematical and Physical Sciences) of the British Association delivered on August 31.

The Microscope

The first example I shall take is the microscope, an instrument which is used in every observational science and, in some form or another, in nearly every industry. The early story of the microscope has been often told, and yet it may be of interest to recall the most important stages in its development. The first instruments consisted of single lenses, actually small globules of glass, which, when the surfaces were suitably ground, yielded in the hands of skilled observers surprisingly good results. The outstanding example is the Dutch naturalist Leeuwenhoek, who during the period 1674–1723, using a microscope of this type, discovered the protozoa and bacteria, and made many other biological observations of supreme importance.

Hooke, who was Leeuwenhoek's correspondent, was working in microscopical problems at the same time, and in the "Micrographia" (1665) described his own microscope—the first compound microscope. The optical system of this instrument consisted of a converging lens, called the object-glass, the field lens, and a third lens, the eye lens. Although it has been stated frequently that Hooke first introduced the field lens to enlarge the field of view, there is little doubt that this invention was due to Monconys, who published a short description of a compound microscope made to his design in 1660. This scarcely detracts from the credit due to Hooke, whose publication became so generally known, and whose optical system was universally adopted and remained practically unchanged for more than a hundred years.

Hevelius, in 1673, described in his "Machine Coelestis" a screw-focusing adjustment that he had fitted to an instrument of the Hooke type which was the forerunner of the modern mechanism

adopted (or invented independently) by John Marshall (1663–1725), one of the great opticians at the close of the seventeenth century. Marshall should be remembered by the fact that he was the first to introduce the method of grinding a number of lenses simultaneously, by cementing a number of pieces of glass on to the surface of a large convex spherical block, and working them with a concave spherical tool. This is still the method employed for polishing lenses in quantity. In the modern spectacle lens factory as many as a hundred and fifty are sometimes polished in one block.

Although many variations in the design and mechanical construction of the microscope were made during the eighteenth century and the early years of the nineteenth, yet there is no invention of fundamental importance to record until the construction of the achromatic objective. This was first successfully completed by the French optician Chevalier about 1825, and in England by Tulley working about the same time to the designs of Joseph J. Lister, nearly sixty years after the construction of a successful achromatic telescope objective.

Abbe carried the corrections of the aberrations to a far higher degree of perfection, notably by using glasses of new types which at his suggestion had been worked out by Schott, to produce, about 1886, the so-called apochromatic objective in which the colour correction was greatly improved.

It is difficult to see how the resolving power of the microscope is to be further increased using light from the visible region of the spectrum. The biologist, and particularly the medical man, is anxious to study organisms the structure of which is too fine to be resolved by any object glass when using ordinary white light, the alternative to which is the employment of rays of shorter wave-length, namely, the ultra-violet. Glass lenses are opaque to these short wave-lengths, and therefore lenses made of fused quartz must be used. J. E. Barnard, who has developed a very successful technique in connexion with ultra-violet microscopy, has shown that it is possible to study and photograph living bacteria, which are normally transparent to light from the visible region of the spectrum, without staining and therefore killing them. The use of such short wave-lengths has necessitated the construction of extremely rigid mountings in the microscope body and complete absence of play in the moving parts of the instrument. As showing the perfection of the technique obtained with ultra-violet microscopy, it may be mentioned that it is possible to take a series of photographs of an object in successive parallel planes separated by distances of the order of 0·0002 mm.

The use of short-wave radiations has proved so successful in the case of the ultra-violet microscope that a technique has been developed which offers great possibilities for the use of still shorter radiations. As is well known, a beam of cathode rays can be brought to a focus by passing the beam through a magnetic or electrostatic field, in a manner very similar to that in which light is brought to a focus by a convex lens. In the same way, an electron image of a surface may be formed owing to the fact that the electrons will be scattered by an amount depending on the density (or mass concentration) of the surface on which they impinge. By forming the image on a fluorescent screen it can be rendered visible, or if projected on to a sensitized plate, photographically recorded.

In an instrument designed by Von Borries and Ruska, an electron stream is passed through two specially designed electromagnets (or magnetic lenses), mounted one above the other, which act as equivalents to the objective and eye-piece of an optical microscope. If an object is placed between the poles of the lower magnet, some of the electrons will be scattered by the material of the object and others will be diverted by the magnetic flux so as to form an image of the object in a plane below the magnet. That an image can be formed in this way depends upon the fact that the scattering is proportional to the mass concentration at different parts of the object. The scattering will be greater from the thicker parts than from the thinner ones, and thus the dark parts of the image will correspond to the thick parts of the object, and *vice versa*. Magnifications of about twenty times those obtained with the optical microscope can be obtained. Excellent photographs have been taken of bacteria and bacilli at magnifications of 10,000 and 20,000 diameters.

Sorby, in 1864, was the first to investigate the structure of metals and alloys by the microscope, and although it was a considerable time before his work was appreciated, there is now no metallurgical laboratory worthy of the name that does not possess a microscope by means of which the molecular structure of an alloy can be examined and photographically recorded.

THE TELESCOPE

Although the discovery of the telescope antedated that of the microscope, in its service to mankind it ranks as second to it. The credit of the invention of the telescope must go to a Dutchman, Lippershey; yet it was Galileo who first produced an instrument worthy of the name. He ground and polished his own lenses, and in 1610, with a telescope magnifying thirty-three diameters, discovered the satellites of Jupiter. Amongst his

many astronomical observations he discovered the phases of Venus, and estimated the height of the lunar mountains from the length of their shadows.

Newton pointed out that the focal length of the refracting telescope could not be reduced owing to the refrangibility of light of different colours, and that it was not possible to focus for all the colours simultaneously and thus obtain a sharp image. He measured and calculated the distance between the foci of the red and violet and showed that it was about 1-50th the diameter of the lens. It was to overcome this difficulty that the glasses were made small and of long focal length. It is almost unbelievable that James Bradley, in 1722, measured the diameter of Venus with a telescope having a focal length of 212 ft., the supporting mast being about 45 ft. long.

In 1663, James Gregory suggested the construction of a reflecting telescope, and in 1668 Newton constructed the first practical instrument, having made his own alloy for the mirror and having devised methods for grinding and polishing it. A sentence in his "Optiks" (Bk. I, Pt. 1, Prop. VI, p. 75) shows how serious the position had become: "Seeing therefore the improvement of Telescopes of given length by Refractions is desperate; I contrived heretofore a Perspective by reflexion, using instead of an Object Glass a concave Metal."

The manufacture of satisfactory reflectors was very difficult, and it was not until an instrument maker, James Short of Edinburgh, about 1730, produced instruments with parabolic figuring, that the reflector came into general use. His instruments, even now, may be regarded as examples of first-class workmanship.

Sir William Herschel began making specula in 1774 and constructed a large number of reflecting telescopes, the most famous being his instrument at Slough of 4 ft. aperture and 40 ft. focal length; this was completed in 1789. Unfortunately, the weight (25 cwt.) of the large speculum rendered it liable to distortion, and it is of interest to note that all Herschel's discoveries were made with smaller instruments. More than fifty years later a reflector of 6 ft. aperture and 54 ft. focal length was erected by Lord Rosse at Parsonstown. All these instruments were fitted with metal mirrors which had an unfortunate tendency to tarnish, and re-polishing was apt to spoil the figuring of the mirror. In the modern instrument the metal mirror is replaced by glass which can be re-silvered at intervals. During the last few years aluminium has taken the place of silver as the reflecting surface, the aluminium being deposited on the glass surface under vacuum. The aluminium film does not tarnish, is more robust than silver and has a higher coefficient of reflection for short wave-lengths, and is thus more efficient photographically.

Owing to the increasing demand for telescopes of higher magnification, and of increased light-gathering power, the size of the mirrors used in the modern instruments is steadily increasing. The Mount Wilson Observatory has a telescope with a mirror 100 in. in diameter, and it is a matter of common knowledge that magnificent photographs of nebulæ, etc., have been obtained with it. At the present time an instrument having a mirror 200 in. in diameter is being constructed for the Mount Palomar Observatory. The manufacture of the borosilicate glass (pyrex) block for this mirror, which weighs twenty tons, has been a feat of considerable skill, and if it is successfully ground and polished, as appears likely, it will be a great engineering triumph. We have become so accustomed to success in mounting and operating these large telescopes, that we are apt to forget that this is the heaviest and certainly the most impressive side of instrument construction work.

For the large telescope the reflector has established itself as the most satisfactory instrument, whereas for the smaller telescope, and for the everyday purposes of life, the refractor is still the more efficient. In 1733, Chester Moor Hall found that by combining lenses made from glasses having different refractive indexes he was able to correct for the unequal refrangibility of light of different wave-lengths, and succeeded in making lenses which produced images free from colour. The same discovery was made independently by John Dolland, who, in 1758, produced an achromatic telescope in which the object glass consisted of a convex lens of crown glass combined with a concave lens of flint glass. The invention of the achromatic lens must be considered as one of the milestones in the development of scientific instruments.

The Spectroscope

Perhaps there is no instrument which in recent times has aided pure science so much, and is now beginning to help industry, as the spectroscope. Fraunhofer constructed the first spectroscope in 1817, and made the first measurements of the lines of the solar spectrum. He was also the first to observe the spectrum of the electric spark. In 1842, Becquerel and Draper independently photographed the solar spectrum on daguerreotype plates, thus laying the foundation for the modern science of spectroscopy.

In 1859, Kirchhoff showed that the luminous vapour of a metal has the property of absorbing the same kind of light as it emits at the same temperature. Kirchhoff recognized the funda-

mental importance of his discovery, entitling it "spectrum analysis"; but it is largely due to Hartley (1882) and later to Twyman, who designed simple and efficient instruments, that spectroscopic analysis has become a quantitative method of chemical analysis. The spectrograph is now one of the most important tools in the metallurgical and chemical laboratory. In the manufacture of steel it is proving an invaluable check on the quality of the materials, the spectrogram obtained from the sample under test being compared with that taken from a standard. The speed of analysis may be judged from the statement that it is possible for one man to analyse twelve samples of nickel-chromium-molybdenum steel spectrochemically for the elements silicon, manganese, nickel, chromium, molybdenum, vanadium, aluminium and copper in less than one day. The spectroscope has also become a tool in common use in the steel warehouse, the storekeeper being able by its means to detect any mixing of the batches of steels.

In the laboratories of the works producing non-ferrous materials the spectroscope is proving equally efficient. For example, the failure of lead pipes from causes other than frost has been considerable, and has been traced to impurities in the lead. A spectroscopic examination of the pipe that has failed shows in a few minutes the undesirable impurities present, and, if the examination is carried further, the quantities of those impurities.

Our knowledge of the constitution of the celestial bodies is almost entirely due to the spectroscope. By its means it has been possible to discover what elements are present in the vapour surrounding them. This was strikingly shown by the discovery by Lockyer, in 1868, of an unknown gas (helium) in the bright-line spectrum of the sun's atmosphere, which was identified by Ramsay twenty-seven years later in the terrestrial atmosphere. The photographing of the sun's disk in a limited band of wave-lengths has led to the development of a special form of recording spectroscope, the photo-spectro-heliograph. In this instrument the slit of a spectroscope is slowly traversed across the sun's image, the selected radiation falling upon a photographic plate. Thus a picture of the sun is built up from a series of photographs taken in the selected wave-lengths. For example, if the wave-length selected is one of calcium, a picture of the disk is obtained showing the distribution of calcium over the sun's surface. The major part of the knowledge obtained about the double stars and also the determination of the velocity of stars in the line of sight has been obtained from spectroscopic observations. The theory of the expanding universe may be said to rest on spectroscopic observations.

SURVEYING INSTRUMENTS

The distinction between the telescope suitably mounted to survey the heavens and that used to measure distances upon the earth's surface is a faint one. The transit instrument is in general only a larger form of theodolite. The early surveyors (and here we may go back to early Egyptian times) made plans by means of rods and plummets; but it was not until the invention of the astrolabe and the use of a divided circle fitted with sights that accurate surveying was attempted. The first mention of the word 'theodolite' occurs in a book "Pantometria" (1571) by an Englishman, Thomas Digges. (It is a matter of interest that Digges has some claim to be called the inventor of the telescope). The early the odolites, like the astronomical instruments, were fitted with pin-hole sights: in the case of the latter instruments, an important controversy arose between Hooke and Hevelius (1679) concerning the relative advantages of telescopic and open sights. Although Hevelius was not convinced, the telescopic sight was almost invariably used after that date. Mention should be made that William Gascoigne invented the filar micrometer and fitted it to a telescope in 1640: this invention greatly increased the accuracy of instruments to which it was attached. Bradley's observation in 1722 shows that he used a form of filar micrometer with considerable success.

As the demands of the astronomer (and later of the surveyor) increased, so the need for improved divided circles became more urgent. The accurate dividing of circles has always been one of the more difficult tasks of the instrument maker, and it is almost entirely due to the English manufacturer that the art of dividing has reached its present high position.

In 1766 Jesse Ramsden made his first circular dividing engine, but as it was not sufficiently accurate for dividing the scales of nautical instruments, he completed a second machine nine years later. It was with this machine that he divided the circles of the 3-ft. theodolites used in the principal triangulation of Great Britain and Ireland, 1792–1862. They were divided to 10 minutes and read to one second of arc by three micrometer microscopes.

In 1826, William Simms invented the self-acting mechanism by means of which the dividing machine became completely automatic, thus saving an immense amount of time, and reducing the risk of error in the dividing of a circle. A similar but larger machine, built by G. W. Watts in 1905, is capable of dividing a circle 4 ft. 6 in. in diameter to 30 seconds of arc with an error not exceeding ± 1 second.

Linear scales are automatically divided by somewhat similar machines in which are fitted a temperature compensation device for variation in the temperature of the machine and a compensation device for correcting for any variations in the pitch of the master screw. In this connexion the scientific man and the instrument maker are alike indebted to the late Dr. C. Guillaume for the invention of 'invar', a nickel-steel alloy having a remarkably small temperature coefficient of expansion, and hence an almost ideal material from which to manufacture standard scale and measuring tapes. In the case of linear scales, the position of the lines in a good metre scale can be guaranteed to an accuracy of 0·002 mm.

The Thermionic Valve

An address of this nature would be incomplete if no mention were made of the thermionic valve. Its advent has led not only to the birth of a wide range of new instruments otherwise impracticable, but also to the simplification of many measuring techniques. The thermionic voltmeter was one of the first, if not the first, measuring instrument employing directly a valve, and uses to the full its most valuable characteristics as a measuring device. These characteristics may be briefly summed up as rectification, amplification, rapidity of response, and high impedance. Although these are the prime considerations, others, such as high overload capacity, are advantageous. The rectifying action combined with amplification enables alternating currents and voltages as small as 10^{-4} ampere and 10^{-4} volt to be measured, using a robust moving-coil instrument as a direct reading indicator. The low electrical inertia and high input impedance have, when using suitable diode valves, enabled voltages and frequencies up to 100 megacycles to be measured with reasonable accuracy by robust commercial instruments.

Manufacture of Scientific Instruments

Looking back over forty years' experience in the use of scientific instruments, many of those years being spent in their manufacture and development, I am much impressed with the steadily growing demands for higher accuracy. The development of the high-speed steam engine, and later the motor-car, brought about an insistent demand for accurate tools and gauges. This in its turn necessitated better design in the tools and more accurate measuring instruments. The manufacture of interchangeable components in large quantities has still further increased the demand for accuracy. The introduction of the new alloy steels with the special technique required in their heat treatment created a demand for precision thermometry.

The attitude of the manufacturer towards the scientific instrument has completely altered. He was once sceptical as to its usefulness ; he is rarely so nowadays. In the majority of large works the general control over the instruments is now in the hands of a technically trained man, and that in itself relieves the instrument maker of much anxiety. Another fact that impresses one is the great difference between the methods of manufacture during the same period. Forty or fifty years ago, instruments were made in small batches, often by individual workmen. In London they were frequently made for some well-known firm by small chamber men who put the name of that firm upon them. As a result of this procedure, the so-called manufacturer very often had not an adequate knowledge of his products : this practice has almost entirely disappeared, to the benefit of customer and maker.

The increased demand for instruments has led to manufacture in the modern sense of the word. An instrument is carefully designed in the drawing office in consultation with the technical expert. The methods by which the instrument is to be made are considered. If the quantities are large, and if a preliminary model has been approved, then the possibility of the use of die castings, hot pressings or plastic mouldings must be considered, and the importance of interchangeability of components emphasized.

In preparing the design of an instrument it must never be forgotten that a good design helps production. It always pays to spend time in the drawing office rather than in the workshop. The application of geometric design, the early exponents of which were Maxwell and Horace Darwin, often reduces the cost of manufacture and makes a better instrument. I think that the experimentalist, in making up his own instrument, should consider whether he can obtain the same result by a simply designed geometric piece of apparatus, rather than the more elaborate design to which he may be attracted.

The demand for instruments is ever growing. As new problems arise, both in science and in industry, the requirements become more stringent. The instrument maker constantly receives incentives to progress from the scientific worker, to whom he owes not only suggestions but also many of his new materials. It is, I suppose, a truism that if knowledge is to progress it is essential that theory and practice advance together. Nowhere is this more true than in the development of scientific instruments.

THE ASSESSMENT OF PHYSICAL FITNESS*

BY PROF. DAVID BURNS

TESTS which have been used to assess fitness fall into three classes: (1) somatometric; (2) physiological; (3) psychological.

SOMATOMETRIC TESTS

The search for a relationship between the configuration of the body and physical fitness has been pursued since the time of Hippocrates. Such a relationship is elusive, and because of the complexity of body build and the scarcity of strictly comparable measurements, most of the findings lack validity.

It was natural, at first, to consider stature as an index of robustness. The tall man with a long reach was better able to hold his own in hand-to-hand fighting. Even to-day, height is taken into account in selecting recruits for the services and the police. The tall applicant, too, has generally a better chance of getting engaged in commerce and industry than his shorter competitor. Length, especially length of leg, is not merely an indication of genetic constitution but also of a late incidence of maturity. Chest girth in relation to size of body, at first sight, appears to have at least a probable relationship to fitness, but Gould (1864), who carried out a thorough statistical survey of the manhood of the American nation during the progress of the Civil War, had grave doubts as to the validity of chest measurements for this purpose. Hutchinson showed clearly that the circumference of the chest is no measure of vital capacity, endurance or even of muscular strength, nor is there any evidence that it bears any relationship to the state of general health.

Criteria of Fitness. Since the introduction by McLaren of systematic somatometric measurements as part of the routine of physical education, there has arisen a host of indexes, of which perhaps the best known are Von Pirquet's Pelidisi and Franzen's A.C.H. indexes.

In general, chests may be divided into three types: the wine-glass—wide shoulders and narrow hips; the test-tube—both measurements small; and the barrel with broad shoulders and wide hips. Persons of the test-tube type are often abdominal breathers, that is, they obtain their tidal air by contracting the diaphragm and displacing the viscera into a relaxed abdominal wall. Experiment shows that they have a larger effective vital capacity than the others and are generally more amenable to training. On the other hand, all three types are normal and are equally fitted, so far as bodily relations go, for the battle of life. One cannot mark down any type as fundamentally healthier than the others. The test-tube type is more prone to tuberculosis but less prone to rheumatism, diabetes and arterio-sclerosis than the barrel.

None of these indexes is valid as a measure of fitness, even when due allowance is made for race, type of body build, sex or occupation.

PHYSIOLOGICAL TESTS

Fitness is functional. The body must be tested at work. The measurement of vital capacity is generally classed as physiological although it is not strictly functional. This measurement, a common routine practice, has no real significance. The amount of air that a person can contain in his lungs is a measure of chest capacity and of the tone of the respiratory musculature, but the person with an extra large vital capacity has no advantage over one who has quite a small capacity provided that he has sufficient.

There is a prevalent error that so-called deep-breathing exercises where the shoulders are forced back and the chest brought forwards and upwards increase vital capacity. Actually, by fixing the pectoral muscles and stretching the abdominal wall, these procedures prevent full inspiration and expiration and increase the volume of air left in the lungs (residual air). Chest breathers have about the same vital capacity, whether taken at ease or on the stretch, while 'deep breathing' may reduce the vital capacity of abdominal breathers by about 30 per cent. The value of deep-breathing exercise lies in its effect on the filling of the heart and so on the maintenance of cardiac efficiency.

One is on surer ground when using the various breath-holding tests either *per se* or against pressure. The former is a measure of the alkali reserve of the blood and of the determination of the subject not to give in. The 40-mm. test brings out both these qualities and, in addition, is a severe test of muscular strength and control.

Bainbridge and Dawson quote the results of experiments which show clearly that fit and/or

* From the presidential address to Section I (Physiology) of the British Association, Dundee.

skilled men carry out physical work with but a slight increase in lactic acid, while the unfit, under the same conditions, have a higher blood-lactic acid content. That is, the reserve of alkali in the blood of the fit is large enough to cope with all or most of the acid released as a result of muscular exercise. Recruits have on the average 5 per cent less available base than the soldiers. Dawson states that three months' systematic physical education can raise the amount of available base by about 10 per cent.

Similar 'fitnesses' associated with other groups of muscles can be tested by various dynamometers. Martin introduced a new procedure into this type of test. Instead of measuring the strength of a subject's active pull on a dynamometer, he applied the pulling force to groups of muscles and recorded the force necessary to break down the subject's active resistance to the movement of the muscle-group under test. The summation of a series of selected groups of muscles thus gives an indication of the total muscular strength of that individual as well as of his determination to resist. It gives no measure of his skill or of his economy of movement. It may be asked: Is muscular strength plus determination an adequate measure of general fitness?

Limiting Factor of Efficiency. It is well known that the limiting factor, the factor which determines whether muscular strength can be exerted to its full extent, the factor which overrides the will to do, is vaso-cardiac efficiency. Goodall recognized this when he published his efficiency tests. If, after a measured amount of exercise, the pulse rate and blood pressure come back to normal in a specified time, depending on the severity of the exertion, then the subject of the test is fit.

With a healthy heart, cardiac efficiency ultimately depends on the venous filling. A pump without a well may be a thing of beauty, the last word in mechanical efficiency, but its usefulness is non-existent. About 85 per cent of the total volume of the blood is in the capillaries and veins under normal conditions. Under these conditions, all capillaries are not patent at any one time. The splanchnic viscera, and particularly the liver and the spleen with their rich venous supply, are capable of retaining much larger quantities of blood than they do. If, for any reason, more capillaries open up at the same time and the splanchnic reservoir becomes filled with blood, the amount freely circulating, the amount necessary to fill the receiving chambers of the heart, becomes inadequate. The controlling factor in the distribution of blood, in maintaining an effective circulation, lies mainly in the tone of muscle—cardiac, visceral and, last but by no means least, ordinary skeletal muscle.

The venous return is also aided by the rhythmic alterations of intra-thoracic pressure with the phases of the respiratory act. It is, however, only in abdominal breathing that the respiratory act aids the return of blood to the heart. These alternating pushes and pulls, produced by muscular action dependent on the tone of the diaphragm and muscles of the abdominal wall, have a minor effect on venous return in comparison with the constant tonic push of muscle in general. During exercise, more capillaries in muscle become patent and, if muscle is in good tone, more blood is put under tissue pressure. On the other hand, if tone is at a low level, blood filling the capillaries is not pressed out, congestion appears and the heart fails through lack of blood. The fit person whose heart is able so to increase its output per unit of time that adequate blood is supplied to active tissues to meet their increased needs, must have a higher value of muscle tone than the unfit. Experiment shows that healthy young men have a tone in their relaxed left biceps muscle which is capable of withstanding a pressure of 60–90 mm. of water, while patients in bed have an intra-muscular pressure of about 50 mm. of water.

Intra-muscular pressure is markedly increased when muscle contracts, so that, as the fibres in muscle shorten intermittently during exercise, the blood is expelled from the venules in the muscles intermittently. This pulsation plays an important part in maintaining the tone of the vessel walls. The hæmostasis produced by immobile standing, shown by swelling of the legs in unfit persons, may be prevented by almost imperceptible voluntary twitches of the calf muscles or even by movements of the toes. Standing rigidly at attention is a severe test of the efficiency of the mechanisms responsible for the venous return to the heart.

Muscular tone is dependent on many factors—adequate blood supply, absence of excess of fatty upholstery, a regular arrival of motor impulses to the muscle controlled from higher centres and a cooling mechanism nicely co-ordinated to the needs of the moment. It is easy to demonstrate that faulty heat loss lowers tone. The avenue by which heat is lost is apparently unimportant, but, unless under the artificial conditions of the laboratory, where even loss by radiation can be made the effective sole method of losing heat, the evaporation of moisture from the skin is the usual limiting factor. Several investigators have shown that the phenomenon known as 'second-wind', by which a runner experiences a sudden relief from the agony of breathlessness and the leaden drag of weary muscles, is accompanied by sweating. When this occurs, alveolar carbon dioxide falls, the urgency of breathlessness fades, the head clears and the muscles act with renewed vigour.

Measures of Fitness. Three means of measuring fitness are thus indicated, and they are interrelated: (*a*) Tests of recuperative efficiency. The ability of the cardio-respiratory mechanism to return to normal functioning within a limited time after exertion. (*b*) The ease of heat loss under specified conditions. (*c*) The value of muscle tone.

(*a*) Tests such as Goodall's, Crampton's, Foster's, McCurdy's and Schneider's, which depend on arbitrary scoring for rise of pulse rate, blood-pressure and respiration rate after exercise, and scoring for the length of time for a return to pre-exercise levels, have a very low coefficient of reliability. Schneider's is the best, with $r=0{\cdot}4$. McCloy prefers to measure alterations in diastolic pressure and pulse rate on standing erect after lying supine. For this r was between 0·8 and 0·9 in a limited study of healthy and convalescent golfers.

Turner's test, which depends on the cardio-vascular reactions during standing absolutely still for 15 minutes, has a coefficient of reliability of above 0·9 for adults but yields anomalous results with boys. In Schneider and Crampton's studies of pre-adolescent boys, the boy proved least fit by all other tests was the sole survivor at the end of 15 minutes' standing (with a pulse pressure of 8 mm. mercury !). The others had either given in or had fainted.

The rate at which the oxygen debt is repaid may be used as an index of physical solvency. The fit subject either pays cash to close the transaction or demands short credit. The percentage of the total debt liquidated during 3 minutes after the cessation of exercise is, in the case of the unfit, about 30, while the same subject, in condition, may have discharged more than 60 per cent of his debt. The drawback to the employment of tests of recuperative power is the possibility of overstraining the vaso-cardiac mechanism in the unsound.

(*b*) No large series of experiments has yet been planned to gauge the reliability of this test of efficiency.

(*c*) The value of muscle tone may be determined in various ways. Coffey, Barnum and Henderson used the knee-jerk as an index of tonus. Even when absolutely uniform strokes of the hammer are applied to the patellar tendon of a co-operating subject, variable degrees of the extent of kick are obtained with successive stimuli. It is a useful method to demonstrate the gross alterations for which these workers used it, but, principally because it requires a trained subject for accurate results, it is not of general utility. The direct reading of intra-muscular pressure is awkward and somewhat unpleasant for the subject. Several attempts have been made to link creatinine excretion with muscle tone.

Noël Paton, in his presidential address to Section I at Bournemouth in 1919, put forward the suggestion that the maintenance of muscle tone (and hence of physical fitness) depended in part on the presence in tissue-fluid of small quantities of guanidine or its methyl derivative. He showed unequivocally that muscle, either of warm- or cold-blooded animals, increased in tone when minute amounts of the salts of this base were administered. Since then much work has been done to elucidate this problem. Sullivan was able to estimate the urinary guanidines in cases of progressive muscular dystrophy before and during treatment. As the cases improved, under glycortal medication, simple guanidines disappeared from the urine. More recently, Minot has successfully treated patients suffering from this disease by oral administration of guanidine hydrochloride; and Dewar, working in my laboratory, has confirmed this (using the tasteless carbonate). Unfortunately, exhaustive search has failed to find a reliable method for the estimation of urinary or blood guanidine, and so, as a test of tone, the determination of the simple guanidines is, at present, unavailable.

The sympathetic control of muscle tone has been the subject of many investigations and much controversy. There is a wealth of indisputable evidence that the anatomical sympathetic system plays, at best, a minor part in the direct maintenance of muscle tone, and no one now holds the views of Hunter or of Royle. On the other hand, the work of the Orbeli school, amply confirmed by later experimenters from other laboratories, points to the influence of adrenergic nerves on the neuromuscular mechanism. This influence is shown more clearly when the action of the vasoconstrictor fibres is removed by poisoning with ergotoxine. This may be taken to mean that the main function of the sympathetic in the maintenance of muscular tone lies in ensuring effective vasodilatation of the muscle capillaries brought about through the so-called 'nutrition reflex'. The fit man, with good muscle tone, soon stops the drain on the blood supply to skin and viscera, while the unfit keeps the pallor of skin for some time and may even show signs of acute digestive upset. One may, therefore, test fitness by estimating the degree (amount × time) of the deprivation of the skin of moving blood.

The responsiveness of the sympathetic arm of the reflex arc depends on the functioning of the cortices of the suprarenal glands. This pair of ductless glands with a long ancestral history is absolutely necessary for life and is affected by any undue strain on the reserves of strength. The will to endure, to keep going on, is mental, but the power to force an unwilling body to obey the order of the mind, to exert its last ounce and not die in the

last ditch, depends, in the end, on the adequacy of the secretory mechanism of the cortices suprarenales. Animals with grafts of cortical tissues and no medullæ act as normals. Injection of cortical extract to completely adrenalectomized rats restores voluntary activity to an extent depending on the amount of cortin given. Hypertrophy of cortical tissues follows exercise in the rat. "Possibly", says Dill, "one of the effects of training is to increase the secretory activity of the adrenal cortex."

The sequelæ of severe muscular exercise under conditions where cooling is inadequate differ only in degree from those of cortical insufficiency, that is, loss of muscle tone, increase of blood potassium and lowering of blood sodium both absolutely and relatively. The loss of tone may be due to imbalance between the metallic ions as well as to exhaustion of cortical supplies, as it may be mirrored in normal subjects by administration of salts of potassium.

Psychological Tests

The fit man carries on his work and his play without an unpleasant degree of fatigue, and so his industrial output may be taken as a measure of his fitness. The amount of work done or the goodness of the work done depends not only on the physical state of the worker but also on the state of his mind. It is well known that work which is in itself pleasant or leads to pleasure as a more or less remote result is carried out with an efficiency lacking in more formal performances or in forced work. L. Hill, Gillespie and many others have shown that the initial cardiac acceleration followed by peripheral and splanchnic vasoconstriction leading to an increased venous return to the heart with consequent cardiac retardation and increased output is mainly psychical in origin. If the work is uninteresting or the movements passive, these preparatory circulatory changes do not take place and the organism as a whole is thus less fitted to do work. Investigations involving treadmills, stationary running, bicycle ergometers, etc., may thus fail to reveal accurately the efficiency of a subject because of the more or less complete lack of interest of the work once the novelty has worn off. The performance becomes a routine and the efficiency consistent but low. On the cessation of the mental effort, the tone of muscle falls, the peripheral and visceral vasoconstriction passes off and output falls. One of the conclusions, drawn from the results of many exhaustive investigations made in the United States and in Great Britain, is that good sociological conditions are of paramount importance if good work is to be expected. Even apparently trivial improvements in amenities lead to increased output. For example, the average output of relays per hour in the Western Electric factory at Chicago of 55·7 when lunch was provided by the management, rose to 66·4 when the employees supplied their own lunch. This rate was maintained over two periods of 31 weeks (of the observation period) and was a record (Whitehead quoted by Dill). Hitler realized this principle, in theory at least, when he instituted his 'Strength through Joy' movement.

Value of 'Stunt' Tests. Cathcart places great value on the ability to react rapidly and accurately to changes in the environment. Efficiency in this can be tested by presenting the subject with exercises which demand new co-ordinations as well as motor activity with a performance both easy and graceful. This type of test, as outlined by Brace, McCloy and others, has a coefficient of validity of more than 0·8.

Exercise and Fitness

What, then, can be said of the effect of exercise in maintaining fitness? The Committee of the Health Section of the League of Nations is rather despondent on this matter. It says, "Up to the present, methods and systems of physical education have not produced any clearly demonstrable effect on the health of the masses, doubtless because the present state of our knowledge is not as yet sufficient to enable us to base them on accurate scientific data" (1938).

Properly designed exercises, carefully controlled, can be used to correct faults of carriage, to eliminate uneconomic muscular actions and fit the mildly dysplastic to take their place without shame among the euplastic. The danger of such exercise lies in any attempt to create an 'ideal' posture, etc., which has no physiological foundation.

Exercise carried on without strain or undue fatigue keeps the body in tone; and some exercise is considered beneficial to those engaged in sedentary occupations especially, as it increases the venous return to the heart and prevents stagnation in the blood reservoirs and lower limbs. The group of experts of the Commission on Physical Training were therefore enjoined "to determine the minimum amount of physical training required to ensure the normal health of the individual".

Exercise designed to 'build muscles' beyond the needs of that particular person merely leads to increased food intake, and when, because of age or lack of opportunity, the amount of exercise is decreased, fibrous and fatty degeneration and infiltration takes place. While it may be 'better to have lov'd and lost', it is certainly not better to have exercised and stopped.

Probably the main beneficial result of keep-fit classes and similar movements is the inculcation of a spirit of independence, personal confidence and

pleasure in performance. Although "the healthy body works in silence" (Carrel), the fit person has a keen sense of the enjoyment to be obtained from suitable exercise. The physiological foundation of the exhilaration resulting from exercise—an exhilaration not entirely due to a decreasing handicap at golf or competitive improvement at other games—would be a suitable and profitable study for ambitious politicians and others.

While it is true that one cannot assess a man's efficiency until his whole life's story has been unrolled (and then it is too late to do anything about it), one should be able to establish norms related to age and sex. The recent Military Service Act provides an occasion for the audit of the nation's young manhood, and, provided suitable tests are applied by properly trained examiners, a beginning will have been made to the collection of facts and figures from which much may be learned.

There is no doubt as to the improvement in mental and physical fitness that results from wise physical training, co-operative effort and good feeding such as that obtained in military camps of the best type. Such training may go far towards reconditioning some of the youth of Great Britain. The American Department of Labour, in a report (1935) on two years' experience of civilian conservation camps, says, "Thousands of actual case records reflect the fact that the C.C.C. men have returned to their homes definitely benefited physically and mentally; their outlook toward the future is brighter, their sense of self-reliance and their ability to adjust themselves to economic conditions is stronger." To this tribute to wise and varied physical, mental and moral education one may add the results of a short experiment in effectively reconditioning a selected number of rejected recruits for the British Army: "My predecessor started a depot for training a limited number of men who were below standard and, as a result, . . . 576 of the 600 . . . have reached the full standard of fitness" (Right Hon. L. Hore-Belisha, Devonport, 1937).

While not in any way detracting from the importance of work of this type on men during late adolescence and early maturity, one may ask why the audit is not made earlier in the course of our national business of turning out citizens—taken early before the debit balance of wasted lives becomes so large that strenuous measures have to be taken to safeguard our interests. No factory the products of which were good, bad and indifferent would exist long before the shareholders were demanding an inquiry and a change of directorship. Our national strength lies in our men and women and not in the machines that they tend or the battleships that they man. To be really great a State must have citizens fit in body and also in mind. "The health of the intelligence and of the affective sense, moral discipline and spiritual development are just as necessary as the health of the body and the prevention of infectious diseases" (Carrel).

To ensure this would cost money, but so does radium. The chief use of this rare element is to prolong the life of the aged; should we not be equally ready to foot a bill which would make young lives more fit to bear hopefully and without undue strain the heavy burden their ancestry has laid on them?

OBITUARIES

Mr. H. P. Hollis

ASTRONOMICAL circles will miss the familiar figure of H. P. Hollis, who died on August 7 at the age of eighty-one years. Hollis was born on January 9, 1858, and was educated at Westminster, from which he went to Jesus College, Cambridge. He took his degree in 1880 and in the following year was appointed to the post of assistant at the Royal Observatory, Greenwich, where he remained for forty years, retiring in 1920. His work at first was connected with the regular astronomical observations with the transit and altazimuth instruments; but later he took part in the measurement and reduction of solar photographs. Among his various other activities must be mentioned his work in the determination of the difference of longitude between Greenwich and Paris. The reductions of the observations made in 1892 and also in 1901 were carried out under his directions. In 1896 he was promoted to a higher grade and took charge of the work of the Astrographic Chart and Catalogue. A record of his twenty-four years in this department is found in the two volumes which give the positions of the stars as measured on the photographs and also the photographic reproduction of the chart plates, as well as in the two other volumes supplementing these results.

Outside his professional duties at the Royal Observatory, Hollis took a keen interest in astronomy and was always pleased to assist the amateur in his difficulties. For some years he contributed very useful information to the tyro by his letters to the *English Mechanic*. He was an original member of the British Astronomical Association founded in 1890, and was president during 1908–9. In addition to serving on the Council at various times, he repre-

sented the Association on the Geophysical Committee of the Royal Astronomical Society, and contributed a number of valuable papers to the *Journal* of the Association.

In 1884 Hollis was elected a fellow of the Royal Astronomical Society, and served on the Council from 1909 until 1911. A number of papers appeared under his name in the *Monthly Notices* and the *Memoirs*; the last of these was in the *Monthly Notices* **79**, 36 (1918), in which he discussed the magnitudes of Nova Aquilæ, deduced from the photographs which had been taken at the Royal Observatory, Greenwich. He edited the *Observatory* magazine from 1893 until 1912, and for many years was astronomical correspondent to *The Times*, to which he contributed the well-known article, "Stars of the Month". In 1910 his work, "Chats on Astronomy", was published. This was written in a popular style and was specially useful to beginners interested in astronomy.

Hollis maintained his interest in astronomy to the end, in spite of his physical disability. He seldom missed any astronomical meetings, and his mental faculties seemed unimpaired.

In 1882 he married Clara Susanna Clark, who predeceased him in 1932. Two sons and a daughter survive him.

Prof. L. Lévy-Bruhl

WE regret to record the death of Prof. L. Lévy-Bruhl, the distinguished French philosopher and ethnologist, which took place in Paris on March 12 last at the age of eighty-one years.

Lucien Lévy-Bruhl was born on April 10, 1857. For long he had held a foremost place in the development in France of philosophical and sociological studies. He was appointed professor of philosophy in the Sorbonne in 1899 and occupied that chair until 1927, when on his retirement he was appointed honorary professor. He was elected a member of the Academy in 1917. He edited the *Revue philosophique* for many years. During 1927–30 he was president of the Institut française d'Anthropologie, of which he was one of the founders and a constant and enthusiastic attendant at its meetings so far as the calls of a busy life allowed. He had travelled widely, and had made the voyage round the world. He delivered courses of lectures in the universities of many countries outside France, including Egypt and both North and South America.

Although Prof. Lévy-Bruhl was the author of a number of profound works on philosophical topics, he was best known to a wide public in both France and England for his studies of primitive and 'savage' mentality, several of which appeared in English translation, while in France they served to introduce the psychological aspects of social anthropology to a wider circle than is usually attracted by scientific studies. In this field his principal or best known works are "Fonctions mentales dans les Sociétés inférieures" (1910), "Mentalité primitive" (1922), and "Surnaturel et la Nature" (1930). In these and others of a kindred character he developed his theories of primitive mentality as belonging to a mystic and prelogical stage of thought in a graceful and lucid style and with the support of a full documentation of facts.

Mr. Clifford Chaffer, O.B.E.

MR. CLIFFORD CHAFFER, superintendent of the Admiralty Research Laboratory, died suddenly on June 26 at his home at Weybridge, Surrey, at the early age of fifty-four years.

Mr. Chaffer was born on October 25, 1884, at Morley, Yorkshire, and, after going to the Wheelwright Grammar School, Dewsbury, became a scholar of Peterhouse, Cambridge, where he remained from 1903 until 1907. He was 18th wrangler in 1906 and took the National Science Tripos in 1907. On leaving the University he held mathematical masterships for a number of years.

In 1916 Mr. Chaffer was appointed a temporary Instructor Lieutenant in the Royal Navy, and after service at sea he was posted to the Admiralty Compass Department. On demobilization in 1920 he accepted an appointment on the civil staff of the Compass Department where he continued to serve until 1936 when he was transferred to the headquarters staff of the Department of Scientific Research and Experiment at the Admiralty.

He was appointed to the Admiralty Research Laboratory as superintendent in 1937 and in this position his clear judgment, power of recognizing the essential features of the problems with which he was called upon to deal, and his ability to inspire the staffs with his personal keenness and single-minded devotion to duty were of the greatest value in a time of unusual stress.

Baron Joji Sakurai

DR. MARIE STOPES writes: "All that Prof. Donnan says in the first paragraph (NATURE, Aug. 5, p. 234) of his obituary notice of Japan's greatest scientist I should like to endorse from personal experience while an honorary member of the professor's common room in the Imperial University, Tokyo. However, no obituary would be complete without mention of his spiritual and literary sensibilities. These were partly revealed by his interest and proficiency in the profound medieval religious plays 'The Nō' which he and I translated together into English and published under the title 'Plays of Old Japan'. The then Japanese Ambassador, Baron Kato, wrote that they 'placed Western students of Japanese art and literature under a debt of gratitude'. Prof. Sakurai, who was a most faithful friend, was in Great Britain for the Coronation of King George VI, and I had the privilege of viewing it with him. He was one of the few scientists who made one revere him".

We regret to announce the death of Prof. E. Westermarck, formerly professor of sociology in the University of London, aged seventy-seven years.

NEWS AND VIEWS

Sir Richard Gregory and the British Association

SIR RICHARD GREGORY, who has been elected president for the coming year of the British Association, has been connected intimately with its activities for the past forty-three years. Both on the Council and upon sectional committees, his wide knowledge of men and their achievements, his tact and his infinite capacity for work have made his services of special value to the welfare of the Association and the progress of science. At the creation of Section L (Educational Science) in 1901, Sir Richard was one of the secretaries, and he has remained in the closest touch with the Section since that date, serving as president in 1922. No one has done more to keep the Section alive to the more pressing problems of education, and he brought to it the men and women most competent to advise on the special topics of the year's programme. He has also taken a vital part in the work of the committees of sections appointed to inquire into special problems. These committees often comprise a long list of distinguished names, but experience shows that the real work of gathering information and drafting the report falls upon comparatively few. Sir Richard was invariably one of these few. In the past thirty-eight years, he has served upon more than twenty such committees either as chairman, secretary or ordinary member, and it must be remembered that these committees run for several years and report annually.

DURING the early years, Section L was much concerned with the place of a training in scientific method in the curricula of schools of all grades, and devoted itself mainly to scholastic problems. During this period, Sir Richard's services were invaluable. Among the more important reports for which he was in large measure responsible were those on practical and scientific studies and the position of science in the school certificate examination, with which was associated a report upon the influence of examinations on curricula and teaching methods. The first of all these reports, on the teaching of elementary mathematics, has affected profoundly the methods of mathematical teaching in schools of all grades. In later years Section L has been more concerned with the social, industrial and cultural relations of science in school education, and here again Sir Richard's wide knowledge of movements and their leaders has enabled the Section to bring to its assistance those most able and willing to help. He himself gave much time to the reports upon the mental and physical factors in education, to the many aspects of adult education, the effects of the free-place system in secondary schools and to training for overseas life. At the Nottingham meeting Sir Richard induced Mr. H. G. Wells to give his stimulating and provocative address on the informative content of education, which gave rise to a valuable report. Sir Richard was also chairman of the Conference of Delegates of Corresponding Societies in 1921.

No mention has been made thus far of Sir Richard Gregory's connexion during the past forty-five years with NATURE, from the editorial chair of which he retired at the end of last year. But it will be easily recognized that much of his work for Section L was intimately bound up with his wider interests. His zeal for the promotion of scientific research, its popularization and its application to everyday life was well shown when he offered a platform in NATURE early last year for the expression of opinions on the desirability of providing for more direct contact between men of science and public affairs, a movement which came to fruition in the establishment at the Cambridge meeting of the British Association of the new Division for the Social and International Relations of Science, with Sir Richard as its first chairman. During the many years when Sir Richard directed the policy of NATURE, he demonstrated time and again his belief in the mission of science as an instrument for the promotion of social, intellectual and industrial progress, and his election as president of the British Association sets a seal of approval on the action of the Association in forming the new Division. The Association may be assured that its objects, as set forth by its founders, and in particular, two of them, namely, "to obtain a greater degree of national attention to the objects of science, and a removal of those disadvantages which impede its progress", are safe in the hands of its new president.

Recruiting Men with Technical Qualifications

THE Ministry of Labour announces that technical committees associated with University Recruiting Boards have been set up to deal with offers of service from men less than twenty-five years of age with qualifications in engineering, chemistry, metallurgy, physics, the biological sciences and mathematics, in order that they may be allocated to an appropriate form of national service. The committees will sit in all cities with universities or university colleges in Great Britain and Northern Ireland, and applications, which should be made in the first instance to a local office of the Ministry of Labour, will be referred to the technical committees and the University Recruiting Boards. This offer is open to men who are starting on their final year of a degree course, or already hold a university degree in any of the following subjects: engineering, chemistry, metallurgy, physics, the biological sciences (including agriculture) and mathematics (including statistics); and to men who are starting on their final year of study or already hold a Higher National Diploma or Higher National Certificate in mechanical or electrical engineering, or the associateship of the Institute of Chemistry.

War Agricultural Committee

THE Minister of Agriculture and Fisheries has appointed a War Agricultural Executive Committee for each county in England and Wales and has made an Order (The Cultivation of Lands Order, 1939) authorizing these committees to exercise on his behalf certain powers conferred on him by the Defence Regulations for the purpose of increasing home food production in time of war. In a Circular Letter to the committees, the Minister states that they will be given as free a hand as possible to proceed as a matter of urgency with all possible steps to increase the production of foodstuffs in their areas. Their immediate task is to see that additional land is brought under the plough with all speed. The aim is to obtain for next year's harvest an increase of about 1½ million acres in the tillage area in England and Wales compared with the acreage in June last. Each county has been allotted its share of this total, and the committees have been urged to see that every effort is made to complete their allotted tasks—and, if possible, to exceed them. The committees have already been holding informal meetings and have made good progress with their preparatory work.

Roman Temple at Albury, Surrey

ROMANO-BRITISH studies are greatly indebted to the Surrey Archæological Society for the work of excavation and conservation which has been carried out on the site of the Roman temple on Farley Heath, Albury, Surrey, by A. W. G. Lowther and R. G. Goodchild on behalf of the Society. The complete plan of the building has now been traced, and marked out by stones from the original structure, bedded in concrete. The site has been known for a long time. It attracted the attention of Elias Ashmole; and in 1670 and 1847 it was despoiled of much of its stone. Little, however, was known of its structure or its relation to surrounding buildings, if any. Recent excavation has shown, it is reported in *The Times* of August 18, that the temple consisted of a simple cella, or shrine, measuring 18 ft. internally, and surrounded by a corridor, or veranda, 8 ft. wide. It has been too much damaged for any details of the architecture to be known, but red tesserae and red wall plaster hint at the character of the internal decoration. It stood within a polygonal wall, approximately 240 ft. in diameter, which probably was intended to demarcate the sacred enclosure. An inner enclosing wall has been found on the north side. Few smaller antiquities have been found in the recent excavations, the most important being a fragment of a terra-cotta "votive lantern", similar to those found at Ashstead, Surrey, and Verulamium. The ground had been too thoroughly turned over by previous diggers to make it probable that many of the smaller class of objects would be found. Further, the excavations of 1848 had provided a rich spoil—more than 1,000 coins, mostly Roman, but including some rare British in gold and silver, and numerous enamelled brooches, while a thin strip of bronze, crudely embossed with human and animal figures, has since been identified as a pagan priest's ritual sceptre. The foundations of the temple were of local ironstone and chalk from the North Downs, but the superstructure was of Bargate sandstone. Wealden clay had been used for the tiles, baked, in all probability, in the tile-kiln discovered in 1936 in Wykehurst Farm, Cranleigh, four miles away.

Archæological Explorations in the United States

A DETERMINATION to limit public expenditure and opposition to the President in the United States of America have recently eliminated most of the intellectual activities which had been subsidized out of Federal funds in the desire to stimulate prosperity by State aid. Archæological investigations in the field, however, so long as they worked within the States, have survived attack owing to the fact that they provide occupation for a considerable number of the unemployed. This consideration does not affect expeditions working abroad and in the Old World, and these have had to be curtailed on the ground of economy. Nearly one hundred archæological expeditions, it is reported by Science Service of Washington, D.C., have taken the field in the course of the present summer; and of these, thirty-two in twenty-two States are financed as part of the W.P.A. programme, the Government supplying the labour—2,500 men and women in all—for excavation work under the direction of representatives of museums, universities and scientific institutions sponsoring the respective expeditions. Two investigations in particular have been made possible by the advantageous conditions. Of these, one is a combined effort on the part of the Universities of Montana, Wyoming, and other of the south-western States to find evidence of the line of advance of the earliest immigrants into America through the Siberia-Alaska gateway towards the south-west. The other will make a rapid and intensive examination of the mounds and other relics of early occupation in the vast region in the States of Tennessee, Alabama and Texas, which is marked for inundation when the dams of the Tennessee Scheme of water supply are built. It is hoped that it may be possible to trace the relation of the cultures of the Mississippi Valley to those of the south before it is too late, and the evidence disappears for ever.

Excavations at Caerleon

FURTHER excavations on the site of the Roman fortress of Caerleon-on-Usk have been necessitated by building development on two acres at the north-east angle. Evidence for the defences here, it is reported by Lady Fox, who directed the excavation on behalf of the Caerleon Excavation Committee (*The Times*, Aug. 5), comprised the primary clay bank and ditch of the occupation by the Second Augustan Legion in A.D. 75, and the foundations of the stone walls and one of the internal turrets set up about A.D. 100, when the internal early timber buildings were reconstructed in stone. The construction of the rampart roadway, which provided access throughout the circuit of the fortress behind the ramparts, was examined. A block of barracks,

set in pairs, back to back, and providing accommodation for soldiers, with more spacious quarters for the centurions, was found to be in plan similar to those excavated in the south-west corner of the fortress in 1926–9. A coin of Nerva confirmed the date of their erection. Occupation by the Second Legion on this occasion appears to have been short; but in the third century the barracks were thoroughly renovated at a date indicated by the stamp "Leg. II Aug. Anto." as A.D. 212–222. Relics of the latest occupation, not necessarily of a military character, were found in the centurions' quarters, where a tile hearth had been built over a destroyed partition wall, and the moulded base of a column, upside down and partly sunk in the floor, appears to have served as a gaming-table, as several counters were found around it. The associated layers contained fourth century coins and pottery of a late type. In all, 70 coins were found and 90 legionary stamped tiles. Pottery was not abundant, but the most interesting find was a hoard of five gold coins, ranging from two of Nero, A.D. 55 and 61 to Titus and Domitian, A.D. 74 and 73, which was found concealed in a barrack floor, and possibly represents the savings of a soldier, which was left behind when the legion was ordered north.

Health Activities of the Rockefeller Foundation

THE annual report for 1937 of the International Health Division of the Rockefeller Foundation, recently published, gives an account of the projects carried out under the auspices of the Health Division by members of its staff. Virus agents of yellow fever, influenza and other diseases, and certain proteins, including visual purple, have been studied by the use of an analytical ultracentrifuge. By means of a cultured yellow fever virus, a vaccine has been produced with which some 60,000 persons have been inoculated, mostly in Brazil, the results of which show that a practicable safe method of large-scale immunization against yellow fever is now available. Studies on the epidemiology of the jungle form of yellow fever have also been pursued. Tuberculosis, particularly in Jamaica, hookworm disease in Egypt and the United States, and malaria and its mosquito vectors in various countries, are other subjects that have been investigated. In addition to research work, the Foundation renders financial aid to State and local health services and to health education in all parts of the world. The report, which is very readable, includes several plates illustrating the work carried out.

The International Seismological Summary

THE International Seismological Summary for July, August and September 1933 has just come to hand, containing details of the calculations of the initial times and epicentres of 169 earthquakes. Sixty-eight of these epicentres are new and 101 are repetitions from old epicentres, showing the tendency of earthquakes to recur from the same epicentre. Included in the 169 earthquake shocks are 15 which had a focal depth below normal, the deepest being that of August 29, 1933, with epicentre 11·0° S., 69·5° W. (in Bolivia near its junction with Peru and Brazil) and focus 0·085 of the earth's radius below normal. Twelve of these deep focus shocks had their epicentres between 45·4° N., and 20·5° S. latitude, and between 131·5° E. and 170·0° E. longitude, thus showing the deep-seated instability of this region of the earth which has Japan in its north-west corner.

Milk for Mothers and Children

A SCHEME was prepared a short time ago by the Milk Marketing Board and approved by the Minister of Agriculture and Fisheries for the supply of cheap milk to local authorities, and was outlined in a circular issued by the Ministry of Health (Circular 1840. H.M. Stationery Office. 3*d*. net). The aim of the scheme is to enable expectant and nursing mothers and children under five, who cannot afford the full retail price for the milk they need, to obtain a pint of milk per head per day either free or for not more than twopence according to family circumstances. Those wishing to receive milk under the scheme will have first to apply to the local authority and they will then be told whether they are eligible to receive the supply. When authorized, they will ask an approved dairyman to deliver at their home the milk to which they are entitled.

Announcements

THE remainder of the meetings of the British Association which began in Dundee on August 30 were cancelled on September 1. Most of the members present left Dundee on that day.

THE French Academy of Medicine has awarded the Grand Prix Prince Albert I de Monaco to Jules Lefèvre, for his work on biology during the last fifty years.

ON the occasion of the jubilee of the Paris Pasteur Institute the scientific and executive committees of the Institute have awarded the gold Pasteur Medal to Dr. H. Plotz, of New York, and Prof. A. Saenz, of Montevideo, for their contributions to science.

IT is announced in *Aesculape* of May that three new chairs for the history of medicine have been founded in Italy, namely, at Florence, Turin and Sienna, while corresponding chairs in Rumania have been abolished.

DR. W. JUNK writes from The Hague to point out a mistake in Dr. W. T. Calman's review of the British Museum reprint of Linnæus's "Systema Naturae" (NATURE, August 12, p. 269). The tenth edition was not, as there stated, the last published during Linnæus's lifetime. The twelfth edition began publication in 1766, twelve years before the death of the author.

ALL the poisonous snakes and insects in the Zoological Gardens of the Zoological Society of London have recently been destroyed. Several of the more valuable animals have been sent to Whipsnade. The Zoo is again open to the public.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 486.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Forces Associated with Heat Flow in Helium II

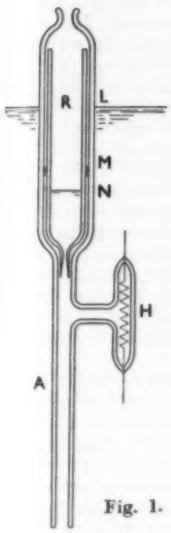

Fig. 1.

IT was discovered some time ago[1] that when heat flowed in helium II down a narrow capillary or through a tube filled with powder, liquid was forced up the tube in the opposite direction. It was considered at the time that the phenomenon, which has been called the 'fountain effect', was associated in some way with the surface of the capillary or of the powder particles. Recent experiments by Daunt and Mendelssohn[2], who have proved the thermodynamic reversibility of the effect, have tended to confirm the idea that it is a surface phenomenon. The thermodynamic aspects of the effect have been treated in a recent paper by H. London[3].

It has now been observed that when heat flows downwards through capillaries of the order of 1 mm. in diameter, the liquid no longer rises above the bath-level, as it does in the fountain effect, but sinks below it. The depression in level has been interpreted as being due to a force which acts on the liquid in the centre of the capillary and which carries the liquid along in the direction of the heat flow. Thus the force associated with the flow of heat in helium II has two components, one a surface effect in which the liquid is forced against the direction of the heat flow, and the other a volume effect in which the liquid in the centre of the channel is forced in the direction of the heat flow. The two effects were observed simultaneously in the apparatus shown in Fig. 1. The reservoir *R* contained a co-axial tube which was drawn to a fine funnel at the bottom so that it fitted into a 1·45 mm. diameter capillary. The funnel opening was about 1 mm. in diameter, which left an annulus of roughly 0·2 mm. width between the mouth of the funnel and the capillary wall. Heat was supplied electrically in the coil *H*, and flowed down the capillary *A* to the bath. The annular reservoir was thus arranged to collect the surface component of the force, the 'fountain effect', whilst the inside reservoir indicated the volume effect, that is, the liquid which is forced down the centre of the capillary. When heat was flowing down the capillary, which was 15 cm. long, the bath-level

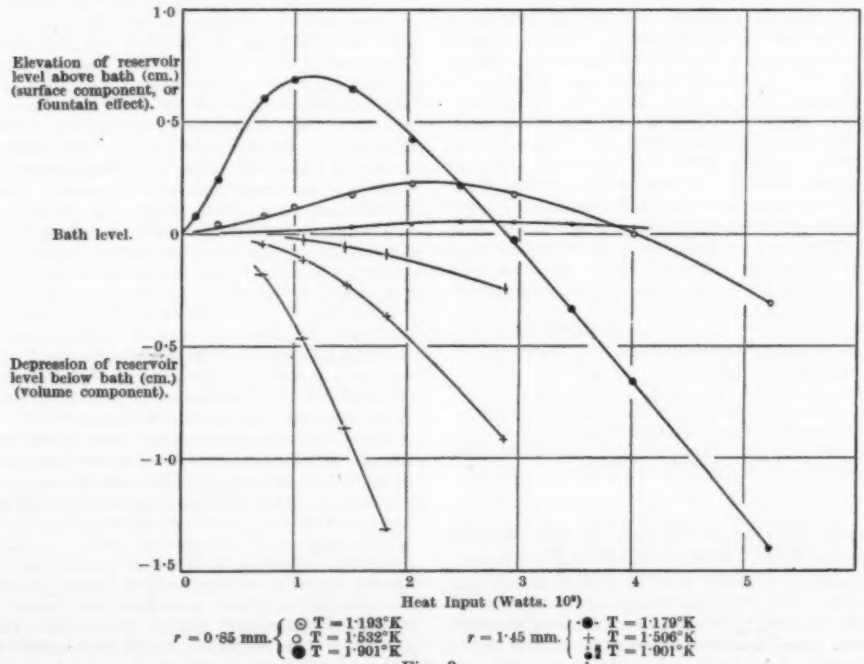

Fig. 2.

and the annular and inner reservoir levels assumed the relative positions L, M and N.

Fig. 2 shows the difference in level between the bath and the inner reservoir at different temperatures as a function of the heat input for two capillary diameters. The figure shows that in a capillary of 1·45 mm. diameter the surface effect is completely swamped by the volume effect, whilst in a capillary of 0·85 mm. diameter inversions take place. In the latter case the surface effect predominates for small heat flow whilst the volume effect predominates for large heat flow. The surface and volume components, therefore, do not appear to be symmetrical with respect to the bath level when considered as a function of temperature. In consequence, one does not find an intermediate capillary diameter which shows no net effect at all temperatures in helium II.

Although previous measurements made on a powder-filled tube indicate that the surface component is approximately a linear function of the heat flow, the nature of the present curves suggests that the surface component becomes saturated at high heat inputs. This would allow the volume component to predominate in a capillary where the total amount of surface is small. Further evidence of the saturation of the surface component was obtained from measurements on a powder-filled tube from which all but a few mm.³ of the powder had been removed. Since both surface and volume components increase in magnitude for given heat input down to the lowest temperatures available, it would be interesting to find out the behaviour of the effects at still lower temperatures.

If both the surface components, as determined from previous measurements, and the present results (largely volume component) are plotted for constant heat input and as a function of the temperature, it is found that they both tend to constant values and not to zero as the temperature approaches the λ-point. The surface effect, however, when plotted as a function of temperature difference, does approach zero at the λ-point[4]. Incomplete measurements on the volume effect indicate that it also behaves in the same way.

The experiments described above help to confirm the ideas previously advanced[1,3] with regard to the fountain effect, namely, that it is associated with the surface of the channel. Although the surface component can be understood from F. London's[5] hypothesis of helium II, based on consideration of Bose-Einstein condensation phenomena, the volume effect presents a further complexity. Much more research will be necessary before a clear theoretical picture of helium II can be produced.

J. F. ALLEN.
Royal Society Mond Laboratory, J. REEKIE.
Cambridge. July 24.

[1] Allen, J. F., and Jones, H., NATURE, 141, 243 (1938).
[2] Daunt, J. G., and Mendelssohn, K., NATURE, 143, 719 (1939).
[3] London, H., *Proc. Roy. Soc.*, A, 171, 484 (1939).
[4] Allen, J. F., and Reekie, J., *Proc. Camb. Phil. Soc.*, 35, 114 (1939).
[5] London, F., *Amer. J. Phys. Chem.*, 43, 49 (1939).

The Electric Quadrupole Moment of the Deuteron and the Field Theory of Nuclear Forces

THE discovery by Rabi and his collaborators[1] that the deuteron in its ground state possesses an electric quadrupole moment is of considerable theoretical importance, since it clearly shows that the forces acting between a proton and a neutron must to a quite appreciable extent depend on the spatial orientations of the spins of the heavy particles. It is well known that the vector meson theory of nuclear forces formally provides such a directional coupling, though of so strongly singular a type that it can only be given a definite meaning by taking recourse to some arbitrary cutting-off prescription. Now, Bethe[2] has recently examined the question how such a cutting-off should be performed, in a theory giving rise to charge-independent nuclear forces, in order to obtain the correct positions of the ground-level and the excited ^1S-level of the deuteron. He was led to the conclusion that, while the way in which the cutting-off is performed is of small influence on the results, the value to be assumed for the cutting-off radius depends critically on the combination of charged and neutral meson fields adopted: if one uses the symmetrical combination of meson fields suggested by Kemmer[3], the cutting-off radius should be chosen larger than the range of the nuclear forces, and a reasonable value of this radius can only be obtained if the meson field is assumed to be purely neutral. This last assumption amounts of course to giving up the remarkable connexions suggested by the symmetrical theory between the problem of nuclear forces and those of cosmic ray phenomena, beta decay and especially the magnetic moments of proton and neutron.

In view of this unsatisfactory feature of the vector meson theory, we should like to point out that the question of the quadrupole moment of the deuteron, as well as the whole problem of the consistency of the meson theory of nuclear forces in its present provisional form, takes a quite different aspect when, as already suggested in a recent note[4], pseudoscalar meson fields are introduced besides the vector fields in such a way as to cancel all strongly singular terms in the static interaction energy of the heavy particles. In such a theory, which necessarily involves the choice of Kemmer's symmetrical combination of charged and neutral fields to account for the charge-independence of the nuclear forces, no question of any cutting-off arises, provided of course the physical interpretation of the formalism is restricted in a way analogous to the so-called correspondence treatment of quantum electrodynamics. At first sight, however, it would seem as though the disappearance of the singular static interaction terms, which just contain the directional coupling of the vector meson theory, would leave no room for such an effect as the quadrupole moment of the deuteron. But it is most readily shown by the method of canonical transformation described in our previous note, that the interaction energy between the heavy particles involves, besides the static interactions hitherto discussed, further significant interaction terms, which represent a directional coupling of the character just required for the occurrence of a quadrupole moment in the ground state of the deuteron.

The non-static interaction terms just mentioned, which contain a factor of the order of magnitude of the ratio of the velocities of the heavy particles to the velocity of light, are also quadratic with respect to the fundamental constants determining the strength of the sources of the meson fields; in fact, if the constants referring to the four-vector and six-vector source densities of the vector meson fields, and to the pseudoscalar and pseudovector source densities of the pseudoscalar meson fields, are denoted by g_1, g_2, f_1, f_2 respectively, these interaction terms are proportional to the products g_1g_2 and f_1f_2. A straight-

forward calculation then shows that the resulting quadrupole moment of the deuteron contains the factor $g_1g_2 + f_1f_2$. The constants referring to the pseudoscalar meson fields are only restricted by the conditions that $|f_2| = |g_2|$ and that $|f_1|$ should not be very much larger than $|g_1|$ or $|g_2|$; the adjustment of the theory to the known energy spectrum of the deuteron fixes the order of magnitude, but not the signs, of g_1 and g_2. Thus, in contrast to the vector meson theory, in which the two cases studied by Bethe correspond to definite values of the quadrupole moment, of opposite signs and very different magnitudes, the theory discussed in the present note would be able to account for any sign and for a wide range of magnitudes of the effect in question. It does not seem possible at present to derive from the measurements an entirely reliable estimate of the effect, owing to the insufficient knowledge of the electronic wave-functions of the hydrogen molecule, which enter in such a derivation. Anyhow, the order of magnitude following from our theory, if we make, for example, the simplest assumption $f_1 = 0$, agrees reasonably well with the provisional empirical value given by Rabi and his collaborators.

A fuller account of the problems discussed in this note and in the previous one will appear in the *Proceedings of the Copenhagen Academy*.

C. MØLLER.
L. ROSENFELD.

Institut for teoretisk Fysik,
Copenhagen.
July 31

* This circumstance was pointed out to one of us in the course of valuable discussions on the subject with Prof. Rabi and Prof. Bethe.

[1] Kellogg, Rabi, Ramsey and Zacharias, *Phys. Rev.*, **55**, 318 (1939).
[2] Bethe, H., *Phys. Rev.*, **55**, 1130 (1939).
[3] Kemmer, N., *Proc. Camb. Phil. Soc.*, **34**, 354 (1938).
[4] Møller, C., and Rosenfeld, L., NATURE, **143**, 241 (1939).

Effect of Temperature on the Intensity of X-ray Reflections from Copper

IN a recent letter in NATURE[1], Prof. E. A. Owen and Mr. R. W. Williams have given results for the effect of temperature on the intensity of X-ray reflections from copper. They find that throughout the range of temperature from 290° to 840° A., the decline of intensity with temperature is greater than predicted by the usual Debye-Waller formula, exp.$-2M$, where M has the well-known expression involving the characteristic temperature Θ which occurs in the Debye theory of specific heats, and that their results agree closely with a temperature factor of the form exp.$-3M$.

The fact that deviations from the Debye-Waller formula occur at the higher temperatures is not surprising, but so large a deviation near room temperature would not be expected. An alternative explanation of the results would be that the value of Θ to be used in the expression for M is not identical with that given by specific heat data. Since M is approximately proportional to $1/\Theta^2$, it follows that instead of changing the numerical factor from 2 to 3, we may take

$$\Theta\,(\text{X-ray}) = \Theta\,(\text{sp. heat}) \times \sqrt{2/3} = 315° \times 0{\cdot}816 = 257°.$$

To test this result we have examined the intensities of reflections from copper at room temperature and liquid air temperature, using two methods to arrive at the temperature factor. (1) Using a mixture of copper and aluminium powders, we have measured the change in the copper intensities in terms of the aluminium intensities, the latter having previously been determined. (2) The second method is to use the relative intensities from the copper powder at the two temperatures and, with cubic metals, these data alone are sufficient to give the temperature factor. Method (1) is probably the more accurate but involves a second substance; method (2) is less accurate but eliminates any comparison substance.

Our results by the two methods are: (1) $\Theta = 310°$ Abs. (2) $\Theta = 297°$ Abs. The uncertainties in these figures are of the order of 4 per cent; that is, about $\pm 12°$. Comparing these with the specific heat value, 315° Abs., we see that while there is a tendency for the X-ray value to be smaller than the specific heat value, there is no marked discrepancy.

Note added after writing the above letter. Prof. Owen and Mr. Williams have kindly informed us of their more recent work on gold, which has yielded results in close agreement with theory (see following letter). This result, considered in conjunction with our own measurements on copper at low temperatures, indicates that no abnormalities are to be expected for copper at higher temperatures, and we think that the suggestion which they make regarding the tarnishing of the copper is quite likely to prove correct.

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University of Leeds.

[1] Owen, E. A., and Williams, R. W., NATURE, **142**, 915 (1938).

Effect of Temperature on the Intensity of X-ray Reflections from Gold

IN a previous letter[1] we referred to some measurements that we carried out on the effect of temperature on the intensity of reflection of X-rays from copper, from which it was concluded that over the range of temperature from about 20° C. to 570° C., the intensity decreased with rise in temperature more nearly in accordance with the temperature factor exp.$(-3M)$ instead of the factor exp.$(-2M)$.

Looked at from another point of view, the characteristic temperature of copper, assuming the exp. $(-2M)$ factor, works out to be 261° K., which is well removed from the accepted value of 315° K. The main difficulty with the measurements was to keep the surface of the copper untarnished, and to meet the difficulty the material was exposed to X-rays when it was maintained at a given temperature in an evacuated chamber.

Similar measurements have now been completed with gold, the surface of which can more easily be kept clean when maintained at high temperature. The results obtained with gold agree more closely with the exp.$(-2M)$ factor, the characteristic temperature working out to be $161 \pm 9°$ K. when the temperature of the material is 445° K. This is in close agreement with the characteristic temperature of 166° K. calculated by Debye from the elastic constants of gold and not far removed from the experimental values of 170° and 175° deduced respectively from specific heats at low temperatures and from electrical conductivity measurements. At higher temperatures the characteristic temperature of gold on the basis of the exp.$(-2M)$ factor turns out to be somewhat lower.

It would be well, therefore, not to accept the results obtained with copper at temperatures above room temperature until further measurements have been made under more rigorous conditions.

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[1] NATURE, 142, 915 (1938).

Observations with Electromagnetic Microbarographs

Two electromagnetic microbarographs designed by H. Benioff to respond to pressure variations in the frequency range from five cycles per second to one cycle in thirty seconds approximately, and with sufficient sensitivity to record the natural unrest of the atmosphere, have been in operation at the Seismological Laboratory in Pasadena for approximately two years. These instruments were operated either at the same point with different characteristics, or at points separated by distances from several to more than 100 metres with identical characteristics. In the short-period galvanometer combination the response is approximately proportional to the rate of change of pressure. For periods of 1 second, the sensitivity is such that 1 mm. deflection of the galvanometer corresponds to a pressure change of 1 dyne per cm.^{2} approximately. The instruments respond to waves as well as to current variations. Discrimination between these two types of movements is made on the basis of their difference in velocity of propagation, the waves being propagated with the velocity of sound, while current variations are propagated with much smaller velocity.

The waves are produced either by natural causes such as earthquakes, surf, other unknown sources or artificial causes (aeroplanes, automobiles, dynamite blasts, gunfire). Waves produced by battleship target practice have been used by Gutenberg to calculate sound velocities and temperatures in the stratosphere. His results agree with those obtained in Central Europe and Novaya Zemlya. The natural waves have predominant periods of 4 sec. and 20 sec. to several hundred seconds, and are largest in winter. They have exhibited no correlation with microseisms.

Air currents produce irregular disturbances throughout the whole range of recorded frequencies. They are due either to ordinary wind or to convection currents resulting from heating of the ground by solar radiation, and ordinarily the two types are not distinguishable from each other in appearance on the records. Both types of movements can be recorded indoors, although under these conditions they are modified in amplitude and in frequency characteristics. They are absent on calm, overcast or foggy days. On clear, calm days convection currents are small in winter, when they are occasionally recorded here from approximately 10 a.m. to 3 p.m. In April and November they occur from approximately 10 a.m. to 4 p.m., and during June and July they appear from 7 a.m. to 7 p.m. Strong currents of either type produce strains in the ground rock as recorded by the strain seismograph. Sudden changes in the characteristics of short-period movements sometimes accompany the passage of a cold front.

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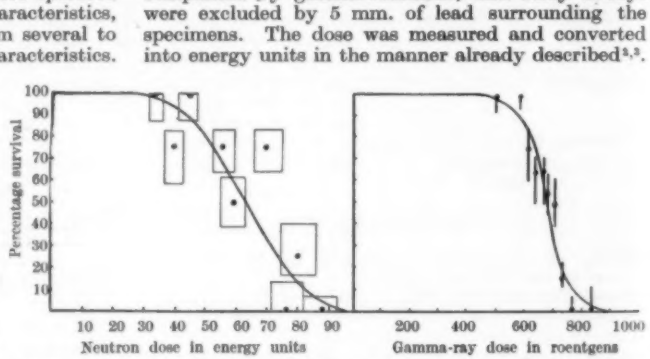
Comparison of the Lethal Effect of Fast Neutrons and Gamma-Rays on the Growing Tips of Broad Bean Roots

THE growing tips of broad bean roots have been irradiated by D-D neutrons ($\sim 2{\cdot}9$ Mev.) and by gamma-rays by techniques already described[1,2]. The duration of irradiation and the variation of intensity along the length of the root was approximately the same for both radiations. The neutrons were unaccompanied by gamma-radiation, and stray X-rays were excluded by 5 mm. of lead surrounding the specimens. The dose was measured and converted into energy units in the manner already described[2,3].



SURVIVAL OF BEAN ROOTS EXPOSED TO NEUTRON AND GAMMA-RAY ENERGY MEASURED IN COMPARABLE UNITS.

The mortality curves for gamma-rays and neutrons are shown in the accompanying figure. The apparent difference in shape between the two curves is not considered to be established in view of the magnitude of the probable errors represented by the rectangles. Individual points on the neutron curve represent the result of irradiating batches of from four to twelve beans. The probable errors of these points were estimated as follows. The probability of observing a certain mortality q in an experiment with N beans, for which the true probability of death corresponding to the dose is p, is :

$$Lt_{x\to\infty}\ {}^{p}{}^{x}C_{qN} \times {}^{(1-P)x}C_{(1-q)N}/{}^{x}C_{N},$$

which, for q constant, is proportional to

$$P^{qN}\ (1-P)^{(1-q)N},$$

Plotting this probability against p, and halving the area on each side of the maximum, we obtain the range of values of p within which it is a 50 per cent chance that the true value of p corresponding to the dose, lies.

It is evident that 50 per cent mortality is produced by 63 ± 6 energy units of neutrons, which may be compared directly with the value of 690 ± 35 roentgens of gamma-rays, since the unit of energy has been defined as the increment of energy per unit volume of water exposed to 1 roentgen of gamma-radiation. Neutron energy thus appears to be about

ten times as efficient as gamma-ray energy in its lethal effect on bean roots.

We gratefully acknowledge the financial assistance of the British Empire Cancer Campaign, and the loan of radium by the Medical Research Council.

Note added in proof. We are advised by a statistician, "It is not correct to say there is a 50 per cent chance that the true value of p corresponding to the dose lies in the range found in the manner described above. This cannot be done without the use of 'inverse probability', which is not justifiable in such cases as this". However, we have treated the data in the manner described on p. 243 of "Biological Effects of Radiation", Vol. 1, Duggar, with the same conclusion regarding the 50 per cent mortality dose.

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July 29.

[1] Mottram, J. C., *Brit. J. Radiol.*, **8**, 32 (1935).
[2] Spear, Gray and Read, NATURE, **142**, 1074 (1938).
[3] Gray and Read, NATURE, **144**, 439 (1939).

Formula for the Change of Velocity of Sound with Temperature

THERE appears to be no simple expression which satisfactorily represents the velocity of sound in air over normal ranges of temperature.

The formula

$$v = 331{\cdot}5 + 0{\cdot}56\,t,$$

in which v is the velocity in metres per second at a temperature $t°$ C., is accurate to three significant figures between − 40° and 100° C. Thus, at 100° C., the expression gives 387·5, which is correct to 0·1 per cent, and at − 40°, 309, which is the value obtained from the Greely and Parry Antarctic measurements.

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Action of Copper Salts on Emulsions Stabilized by Sodium Oleate

DURING experiments on the effect of addition of electrolytes on emulsions of xylene in water stabilized by sodium oleate, we noticed that the xylene thrown out by copper salts was a clear, bright green or blue colour. The same colour was obtained if benzene, even the purest benzene, was used instead of xylene. On adding a quantity of copper salt equivalent to the sodium oleate present in the emulsion, benzene began to separate immediately and a certain amount of inverted emulsion was also formed, which, however, broke after some time. The separated water contained copper. On evaporation of the benzene a dark green, waxy solid was obtained, which on analysis gave a ratio of copper to oleate of 1 : 3·4 and contained some sodium. Dilute solutions of this solid in benzene were blue, more concentrated ones a bright emerald green.

Copper oleate prepared by the interaction of equivalent quantities of copper sulphate and sodium oleate in aqueous solution was, when first precipitated, insoluble in benzene. After allowing it to stand for some time it could be filtered off and obtained as a much paler green, waxy solid, which on analysis gave a ratio of copper to oleate of 1 : 2·05. After it had been kept for some time this solid would dissolve in benzene, presumably because it had lost some water, to give a solution identical in appearance with that obtained when breaking emulsions. Freezing point measurements, however, showed that these solutions were not identical. Copper oleate prepared in aqueous solution caused no depression of the freezing point of benzene (compare the work of Bhatnagar, Kapur and Hussain[1] on magnesium and zinc oleates) whilst the substance obtained on breaking an emulsion did depress the freezing point. Freshly precipitated copper oleate can be made immediately soluble in benzene by the addition of sodium oleate or oleic acid.

Now when our emulsion was completely broken, all the oleate was dissolved in the benzene, but not all of it as ordinary copper oleate, the ratio of copper to oleate being 1 : 3·4. Therefore one might expect that it would not be necessary to add a quantity of copper salt fully equivalent to the sodium oleate present in order to break the emulsion, but only 2/3·4 or 59 per cent of this amount. This expectation was not fulfilled—addition of this quantity of copper salt threw out only about one third of the benzene. We therefore conclude that the copper ion experiences some resistance to penetration to the oleate at the benzene-water interface, perhaps due to strongly attached sodium ions of the inner portion of the diffuse section of the double layer forming a practically continuous protective sheath of bound water around the benzene droplet.

The power of cations to overcome this resistance should be greater the less they are held back by their affinity for the aqueous phase, which affinity is indicated by their position in the lyotropic series. In our experiments on the partial breaking of emulsions by a number of electrolytes, we have found that the order of effectiveness of a number of cations did follow this series; for example, calcium chloride was less effective than strontium chloride, which was less effective than barium chloride, and zinc sulphate was less effective than magnesium sulphate.

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August 1.

[1] Bhatnagar, Kapur, and Hussain, *Proc. Ind. Acad. Sci.*, **9**, A, 143 (1939).

Cholinesterase and Electrolytes

WE have found some effects of electrolytes on the activity of cholinesterase, which may explain the well-known effects of these electrolytes on irritability.

A purified preparation of cholinesterase from horse serum free from electrolytes was used in these experiments. 1 mgm. of the dry enzyme preparation hydrolysed about 100 mgm. of acetylcholine per hour. The esterase activity was measured manometrically.

Calcium and magnesium ions act as activators and potassium ions as inhibitors of cholinesterase. The effects of added calcium, magnesium and potassium depend on the concentration of the substrate; they are more pronounced at low concentrations of acetylcholine. At a concentration of 0·5 per cent of acetylcholine, the activity of the esterase is increased about 30 per cent by calcium or magnesium and decreased about 15 per cent by potassium. At

a concentration of 0·025 per cent of acetylcholine, the increase in enzyme activity by calcium and magnesium amounts to 100–150 per cent, the inhibition by potassium to about 40 per cent. The inhibition by potassium ions is abolished by calcium or magnesium. In a balanced medium, such as Tyrode solution, a decrease in calcium or magnesium has the same effect on esterase activity as an increase in potassium ions. All these effects are brought about by physiological concentrations of the electrolytes. The following table illustrates these facts.

HYDROLYSIS OF ACETYLCHOLINE.

0·05 c.c. purified cholinesterase preparation from horse serum; 0·5 mgm. acetylcholine; 2 c.c. 0·025 mol. sodium bicarbonate; 5 per cent carbon dioxide in nitrogen; 37° C.

Cations added (in form of chlorides).	Acetylcholine hydrolysed in 3 minutes
—	124 γ
0·24 mgm.% Mg	174 γ
2·4 " Mg	249 γ
0·44 " Ca	180 γ
2·2 " Ca	288 γ
400 " K	73 γ
400 " K + 0·72 mgm.% Mg	129 γ
400 " K + 0·55 " Ca	133 γ

The adjuvant actions of potassium on parasympathetic effects and the depressant actions of calcium (and magnesium) on such effects may be explained by the effects of these electrolytes on cholinesterase. Potassium, by inhibiting the esterase activity, would delay the destruction of acetylcholine and thus augment parasympathomimetic effects; calcium and magnesium, on the other hand, by activating the esterase, would accelerate the hydrolysis of acetylcholine, and thus antagonize such effects.

In the same way, the hyper-irritability in the various forms of tetany, known to be associated with a low calcium or magnesium level, may possibly be due to a delayed destruction of the acetylcholine liberated by a motor nerve impulse at the nerve endings. The vasodilatation, observed in magnesium deficiency, may similarly be due to delayed destruction of acetylcholine liberated by impulses in cholinergic vasodilator nerves.

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Can Rusts Fix Nitrogen?

Caldwell *et al.*[1] and Murphy[2] have shown that in wheat and oat plants infected with *Puccinia triticina* and *P. coronata* respectively, the amount of nitrogen, and of some other substances present, is greater than in uninfected plants. Gretschushnikoff[3] found that the rust he studied excreted urea and ammonia, which, he suggested, were removed by the host, since no correlation was found between the severity of the infection and the amount of ammonia and urea in the extracts of the rusted leaves. These facts suggest that rusts may fix atmospheric nitrogen just as some other fungi are believed to do.

Work begun in Cambridge in 1937 and continued in Portugal has suggested that the problem is worth investigating in some detail. The results of two experiments are given below. Six samples each of fifty plants of Jenkin wheat were grown on sand until the plants were showing the second leaf, and after cutting off the roots and grain the plants were washed in distilled water. Samples 1 and 2 were taken at the beginning of the experiment; samples 3 and 4 were placed with their cut ends in water and kept rust free; samples 5 and 6 were placed in water and inoculated with *P. graminis tritici*, race 27. Sample 4 was accidentally destroyed before the close of the experiment. Samples 3, 5 and 6 were collected twelve days after the experiment was begun. The plants when collected were dried and then analysed. The results of the analyses are given in the accompanying table.

		Rust-free	Dry weight in gm.	Absolute nitrogen per gm.
Initial control	{	1	1·2549	0·06804
Final control	{	2	1·2858	0·06038
		3	1·6790	0·06230
		Inoculated		
		5	1·5615	0·07385
		6	1·4406	0·07980

In the second experiment, seedlings of Spratt Archer barley were used. The seedlings were prepared in the way described above; fifty plants were dried for analysis when the experiment was begun. Two samples of 225 plants each were placed with their cut ends in modified Crone's nitrogen-free solution. One sample was kept rust free, the other was infected with *Puccinia anomala* race 12. Fifty seedlings were taken every three days from each sample and dried at once. After twelve days the experiment was discontinued and the samples analysed. The results of the analyses are given below:

		Dry weight in gm.	Absolute nitrogen in gm.
	Initial control	0·7206	0·03012
	Rust-free		
No. of days the seedlings were kept in the solution	3	0·8853	0·0326
	6	0·9908	0·03073
	9	1·0067	0·0326
	12	1·8007	0·02996
	Inoculated		
No. of days the seedlings were kept in the solution	3	0·9156	0·033015
	6	1·1150	0·03458
	9	0·9922	0·03542
	12	0·8836	0·04809

The results of other experiments not given here agree in essentials with those quoted above, although in some experiments with *P. glumarum* the apparent increase in nitrogen content was not so marked. Irregular results were found with other rusts, particularly if the leaves remained wilted for long periods after inoculation. Nevertheless the experiments point to an increase in the amount of nitrogen in the rust-infected plants.

I realize the difficulties involved in demonstrating nitrogen fixation by an obligate parasite, yet I feel that the above results are sufficiently suggestive to warrant their being brought to the notice of other workers.

BRANQUINHO D'OLIVEIRA.

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Belem, Lisbon.
July 5.

[1] Caldwell, Craybill, Sullivan and Compton, *J. Agric. Res.*, **48**, 1049-1071 (1934).
[2] Murphy, H. C., *Phytopath.*, **26**, 220-234 (1936).
[3] Gretschushnikoff, A. I., *C.R. Acad. Sci. U.R.S.S.*, N.S., **2**, 335-340 (1936); (Ref. in *Rev. Appl. Mycol.*, **15**, 710; 1936).

Nomenclature of Nudibranchiate Mollusca

WANTON changes in the nomenclature of animals are so injurious to zoology by confusing its literature, and so heavily handicap the study of systematic problems, that I seek the publicity of NATURE for the exposure of a particularly flagrant case. This is the synonymic List of British Nudibranchiate Mollusca by Iredale and O'Donoghue[1], the nomenclature of which was adopted in the last edition of the "Plymouth Marine Fauna" of the Marine Biological Association (1931). My attention was directed to it by noticing that some extraordinary names for these animals were being used by recent workers at Plymouth, who naturally followed the guidance of the Association's official "Fauna".

The revolutionary nature of the scheme may be seen from the fact that in it familiar names like *Doris*, *Triopa*, *Tritonia* and *Doto* have completely disappeared, and that no less than 40 out of the 71 species recorded bear names different from those in Alder and Hancock's "Monograph", as revised for the Ray Society by the late Sir Charles Eliot in 1910. No reasons were given in the "Fauna" for the rejection of Eliot's nomenclature, and no opinion was expressed as to the validity of the new scheme. As an old student of the group, familiar with the careful workmanship both of Alder and Hancock and of Eliot, I have thought it desirable to subject Iredale and O'Donoghue's paper to a critical examination, and submit herewith a few examples of their treatment.

(1) *Doris* (*Archidoris*) *tuberculata*, Cuvier, 1804.—Our largest and most familiar species of *Doris* has been known exclusively by this name for nearly a century. Iredale and O'Donoghue assert, but without evidence, that it is not Cuvier's species. Their statement traverses the unanimous testimony of Alder and Hancock, Bergh, Eliot, Fischer, Cuénot and Vayssière, in fact of every expert investigator. Their change of its name to *A. britannica* (Johnston, 1838) is baseless.

(2) *Doris* (*Jorunna*) *johnstoni*, A. and H., is another well-known species which has been universally known under this name since Alder and Hancock first accurately defined it in their monograph. Iredale and O'Donoghue change the specific name to *tomentosa*, Cuvier, 1804, on the ground that Fischer (1869, 1870) "pointed out this synonymy" and that Cuénot (1903) "confirmed" it. The facts are that Fischer claimed that *tomentosa*, Cuvier, was distinct from *johnstoni*, while Cuénot said that the synonymy of *johnstoni* with *tomentosa* was at most a "possibility" which could not be established, since Cuvier's description was "*absolument insuffisante*"! Fischer had made a superficial examination of some specimens labelled *D. tomentosa*, Cuv., in the Paris Museum, but the single authentic type was not among them.

Moreover, Iredale and O'Donoghue omit the fact that Bergh conclusively identified as *D. johnstoni* some specimens in the Leyden Museum which Cuvier himself had authenticated as *D. stellata*, Gmel. (Bergh, *Verh. z. b. Ges. Wien*, 1893)—a species of antiquarian interest only, but from which Cuvier had expressly distinguished his own *tomentosa*. Thus, if we assume that *tomentosa* really was identical with *johnstoni*, Cuvier could not recognize his own species when it was before him. Enough has been said to show that the only indisputable name for Alder and Hancock's species remains *Doris* (*Jorunna*) *johnstoni* A. and H.

(3) *Doris verrucosa*, Linn. (Cuv.). This, the type-species of the Linnæan genus *Doris*, had remained unrecognized until Cuvier's "Mémoire sur le genre Doris" (1804). Iredale and O'Donoghue dismiss Cuvier's identification with the assertion that Linnæus's species was "based on a specimen described by Rumph and figured by Séba, which is indeterminable", thus begging an important question and brushing aside essential facts. It is generally admitted that Linnæus's first attempt, in the tenth edition of the "Systema" (1758), to define the sea-slug *Doris* was both erroneous and confused. Cuvier pointed out that Linnæus's citations from Rumph and Séba indicated an "Oscabrion", that is, a Chitonid (Séba's plate suggests a *Cryptochiton* with reflected mantle), but the generic diagnosis included statements about appendages of which there was no indication either in Rumph or Séba ("*Tentacula ad os circiter octo*"). This suggested to Cuvier that, in addition to Séba's figure, Linnæus had a true *Doris* before him, though wrongly orientated, and Bergh, long afterwards, reached the same conclusion. Anyhow, after Bohadsch had cleared up the anatomical errors (1761), Linnæus corrected his diagnosis in the twelfth edition, changed *os* to *anum*, distinguished the true tentacles as "retractile within foramina", and nevertheless retained *verrucosa*, along with three new species of indubitable *Doris*, as members of the revised genus. Cuvier had found some specimens in the old "Cabinet d'Histoire Naturelle" which in fact combined the verrucosity of Séba's figure with the revised generic characters. He accordingly claimed the species, which he described and figured, as in all probability Linnæus's hitherto unrecognized type, and it has since happily proved to be the commonest Mediterranean species.

Cuvier's identification was in every sense legitimate and has been admitted without exception by every subsequent investigator. It was tantamount to a fixation of the type for all time. Accordingly the old genus *Doris* stands, in spite of its original ambiguity, and includes five British species at least, as detailed in Eliot's Revision.

These few examples, out of many similar, show that Iredale and O'Donoghue draw no distinction between proved conclusions and mere opinions. Until the changes of nomenclature introduced by them have been confirmed independently, I would advise serious investigators to record their discoveries under the more stable and historic names of Eliot's authorized Revision.

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WALTER GARSTANG.

[1] *Proc. Malac. Soc.*, **15** (1923).

Chromosome Structure as Observed in Root Tips

THERE are some features of the structure of the somatic chromosome which can be observed without any special technique. These are the primary and the secondary constrictions (the last including the SAT- and the NO-SAT-constrictions) and also the heterochromatin and the euchromatin.

Recently, Darlington and La Cour[1], by means of a special technique, have observed a "new differentiation" in the chromosome which appears as a decrease in its thickness owing, they suggest, to these parts of the chromosome "being coiled in a finer thread of smaller diameter than the rest of the thread".

(*a*) (*b*) (*c*)

METAPHASES OF ROOT TIPS OF *Trillium ovatum*, PURSH; (*c*) IS AN ENLARGEMENT OF THE PART BETWEEN THE ARROWS IN (*b*).

The connexion of the satellites to the chromosomes has been referred to in the literature as 'SAT-thread', although in some cases (Heitz[2] and Resende[3]) this connexion appears more as a band than as a thread. From the comparison of my figure[3] of a SAT-band in *Dioon spinulosum* with the photographs of Darlington and La Cour of *Paris polyphilla*, one can see that there is no difference at all between them. As these authors did not observe the nucleoli, however, it is very likely that they failed to recognize such differentiations as SAT-constrictions. Similar aspects were observed by me in the proximal satellites of *Trillium ovatum* (see *a*) and other plants[4]. In all these cases, as in *Dioon*, the nucleoli have been observed and there can be no doubt that we were dealing with true SAT-differentiations.

In a metaphase preparation of *Trillium ovatum*, in which this SAT-band was particularly extended, one could clearly see that this zone is deprived of kalymma and that the chromonemata there showed a differentiation identical with that observed hitherto only in meiosis (cf. Belling[5]). Exactly as Belling observed in a pachynema of *Lilium pardalinum*, I found in somatic metaphases (root tips) of *Trillium ovatum* (see *b*) groups of four chromomeres linked together by fine (?) fibrils. The observation of such a differentiation in mitosis shows the identity of the somatic chromonemata with those of meiosis.

The present observations are a confirmation of the hypothesis put forward by Heitz[6] on the constitution of the chromosome, but, of course, only with regard to the number of the chromonemata. It is now demonstrated that the chromonema is split longitudinally, as suggested before by several authors (cf. Geitler[7] and Straub[8]). The facts referred to also show that the longitudinal splitting of the chromonema is already present at metaphase.

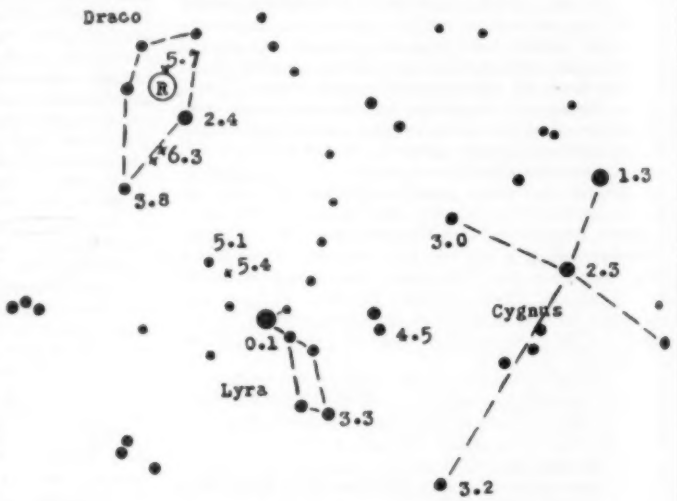
FLÁVIO RESENDE.

Institut für allgemeine Botanik,
Hamburg, 36. June 24.

[1] Darlington, C. D., and La Cour, L., *Ann. Bot.*, N.S. **2** (1938).
[2] Heitz, E., *Planta*, **8** (1931), figs. 14 and 23.
[3] Resende, F., *Planta*, **26** (1937), fig. 26K, see arrow.
[4] Resende, F., *Z. Zellforsch.* In the Press.
[5] Belling, J., after Geitler, Berlin (1938).
[6] Heitz, E., *Z. Abstammslehre*, **70** (1935).
[7] Geitler, L., *Z. Zellforsch.*, 28 (1938).
[8] Straub, J., *Z. Bot.*, **33** (1938).

Giacobinid Meteors in 1939 and 1940?

ON October 9, 1933, when the earth passed through the region occupied eighty days earlier by the faint, short-period comet Giacobini-Zinner, the strongest meteor shower of the century appeared for a few hours. The best available orbit for the comet indicates that it will again pass near the earth's orbit on February 23, 1940; thus in 1939 the earth will precede the comet to the nodal point by 136 days and in 1940 follow it by 229 days. It therefore appears probable that some recurrence of the shower, but of a quite unpredictable intensity, may be anticipated on October 9 or 10 in either or both of these years[1]. Observations from widely separated localities are of great value in the investigation of the internal structure of meteoric swarms, hence a request is made for reports from anyone detecting the shower. The radiant will be in the head of the constellation Draco, north and west of the bright star Vega. In 1939 the moon, aged twenty-five days, will not interfere; but in 1940, aged eight days, it will illuminate the evening sky.



Continued investigation of the Giacobinid system, in which both meteor showers and the comet may be observed, should greatly increase our knowledge of the structure of comets and the process by which they disintegrate into meteor swarms. In the study of the structure of meteor swarms, certain types of data are of especial importance and unless they are obtained and recorded with the more general observations of a meteor shower, the studies are likely to be of little value. For this reason the following observing programme is suggested for a single observer assisted by a recorder. If additional observers are available, the several types of observation may be delegated.

(1) Determine as closely as possible the position and size of the radiant area, and, if possible, fix the position of the radiant area when it is at several appreciably different zenith distances.

(2) Have each observer record the magnitude, or identity, of the faintest star that he can see. If the transparency changes appreciably during the observations, record the stellar limit frequently.

(3) Choose some specific region of the sky, for example, the polar region, or the zenith, and count

the number of meteors seen during intervals of five minutes.

(4) At least once each hour count, over intervals of not less than five minutes, the number of meteors of each magnitude. A continuous record of the magnitudes of all meteors seen, from which any time-variations of the magnitude distribution may be found, would be extremely valuable.

(5) If low-power binoculars or a comet-seeker are available, determine and record the number of meteors of various magnitudes seen through such optical instruments.

(6) Utilize whatever photographic equipment is available for securing both trails and spectra of the meteors. For detailed suggestions see papers by Dr. P. M. Millman[3].

(7) When reporting the observations, give all the data that are obtained and descriptions of the field of view, time system, telescopes, etc., employed. At a later date superfluous information may be disregarded, but omitted data cannot be recreated.

For convenience in identifying the radiant, its approximate position is indicated by R in the accompanying chart. The location and visual magnitudes of a few easily identified, faint stars are also indicated (crosses) to aid in fixing the limit of visibility and in determining the magnitudes of faint meteors.

FLETCHER WATSON.

Harvard Observatory,
Cambridge, Massachusetts.
July 21.

[1] *Pop. Astro.*, **47**, 308 (1939).
[3] *Pop. Astro.*, **41**, 298 (1933); *J. Astro. Soc. Can.*, **31**, 295 (1937); "Amateur Telescope Making, Advanced", p. 544 (New York: Scientific American Press, 1937).

Points from Foregoing Letters

J. F. Allen and J. Reekie state that the force associated with heat flow in He II has been found to possess two components. When heat flows in a tube containing He II, the liquid which is close to the surface of the capillary is forced to flow in the direction opposite to that of the flow of heat. This is the so-called fountain effect. In the centre of the capillary, however, liquid is forced by the flow of heat to move in the same direction as the heat flow. There is evidence that the fountain effect, that is the surface component, becomes saturated when the heat current is sufficiently high.

According to C. Møller and L. Rosenfeld, recent developments of the vector meson theory lead to the view that the meson field is neutral. They state that the quadruple moment of the deuteron, and indeed the consistency of the whole meson theory of nuclear forces, is much clarified by introducing pseudoscalar meson fields as well as the vector fields.

G. W. Brindley and G. H. Atkinson point out that the characteristic temperature of copper obtained from X-ray measurements at low temperatures agrees with the specific heat value, in contradiction to the previously reported result of Owen and Williams obtained from X-ray measurements at high temperatures.

E. A. Owen and R. Wilson Williams find that the characteristic temperature of gold deduced from X-ray measurements agrees with the value obtained by other methods. They suggest that the results which they previously recorded for copper at high temperatures need further investigation under more rigorous conditions.

H. Benioff and B. Gutenberg describe results obtained with electromagnetic microbarographs designed by the former. They respond to the range of frequencies 5 cycles per sec. and to 2 cycles per minute, and are capable of recording the natural movements of the atmosphere. Wave movements, produced by earthquakes, surf or artificial sources, and also air currents can be detected.

The lethal effects of neutrons and γ-rays on broad bean roots are compared by L. H. Gray, J. Read and J. C. Mottram. Using earlier results, it was found that the biological effect produced by a given amount of absorbed γ-ray energy was produced by about one tenth of this amount of absorbed neutron energy.

A. R. Martin and R. N. Hermann find that when a quantity of copper salt equivalent to the sodium oleate present is added to an emulsion of benzene in water, the solid obtained on evaporating the benzene thrown out is different from the product of the interaction of sodium oleate and copper salts in aqueous solution. They make suggestions about the nature of the double layer round the oil droplets in emulsions.

B. Mendel, D. Mundell and F. Strelitz find that calcium and magnesium ions activate and potassium ions inhibit cholinesterase. These effects are brought about by physiological concentrations of the electrolytes and become more pronounced the lower the concentration of acetylcholine.

B. d'Oliveira describes some experiments in which it is shown that the leaves of cereal seedlings experimentally inoculated with some rusts (Puccinia) present an increase of the total amount of nitrogen. The question is put whether rusts are able to fix nitrogen directly from the air.

W. Garstang criticizes the nomenclature of British Nudibranchiate Mollusca which was adopted in the last edition (1931) of the "Plymouth Marine Fauna" of the Marine Biological Association from Iredale and O'Donoghue's Synonymic List of 1923. He gives examples of the unreliability of this list, and advises a return to the nomenclature of Eliot's Revision of Alder and Hancock's Monograph (Ray Society, 1910).

F. Resende submits photomicrographs which he claims support the view that the chromonema is split longitudinally at metaphase.

The possibilities that meteor showers, associated with comet Giacobini-Zinner, will appear on October 9–10, 1939 and 1940 are discussed by F. Watson, and the most valuable types of observations are detailed.

RESEARCH ITEMS

Early Copper

EXPERIMENTS in smelting copper from ores have been carried out by H. H. Coghlan with the view of throwing light on the supposed accidental discovery of copper smelting by primitive man (*Man*, July 1939). Primitive conditions were simulated so far as possible, to show whether copper could be produced in a 'hole in the ground' or camp fire. The green carbonate malachite was selected as the most probable material from which the earliest smelted copper was produced. A cone of charcoal was built up in a hole in the ground about three feet in diameter, and surrounded by a ring of stones. The ore was well embedded in the centre of the cone. A bright red heat was obtained, which could not have been increased without a forced draught. The fire was kept at full heat for some hours, and then allowed to die down slowly. The malachite had only been reduced to black oxide of copper, and no metallic copper was produced. Failure is attributed to excess of air, and later experiments proved that low temperature was not the cause of failure. The theory of accidental discovery precludes the use of bellows to produce a forced draught, as this is a method which belongs to a sophisticated copper-smelting technique. An alternative theory is put forward that accidental discovery may have resulted from the employment of a pottery kiln, especially in view of the fact that the use of pottery preceded the discovery of copper. A test was made in a simple kiln, such as that which had been in use at Erosd in the Alt Valley, where the baking chamber was simply a dome of brick or burnt clay. The kiln following this model was covered with charcoal, and the fire kept at a good red heat for some hours. Metallic copper was produced, at first as sponge copper, and afterwards with a closer packing, as a compact and close-grained bead. The malachite may have been introduced into the primitive pottery kiln by accident or in the form of a paint or slip, or made up as a glaze.

Tree Ritual in Southern Rhodesia

A NUMBER of examples of tree ritual among the Bantu tribes of Southern Rhodesia have been collected by F. Posselt (*Man*, August, 1939). In the Marandellas District, Central Mashonaland, a tree on a ridge, a prominent landmark, was known to the natives as "the tree without a name", so-called because it was the only one of its kind. Before British occupation in 1890, religious rites were performed around it, particularly by the Barozwi. The assembly danced around it and made offerings of black cloth and beads. The tree was believed to be the abode of a great tribal spirit; and the rites were intended to propitiate, and ensure the prosperity of the community, as well as a bountiful season. The sacred grove of the *miti michena*, "the white trees", was the scene of a ritual murder of human sacrifice in 1923. This grove, in the Darwin District, Northern Mashonaland, is the centre of the Karuwa cult of the Rainmaker, whose wife was obliged to live within the enclosure to which no male, except the officiating priest, was admitted. Contact with any male defiled the spirit's wife and was regarded as a rape, with the result that the angered spirit visited the land with a prolonged drought, refusing to be reconciled until the offending male had been immolated. The chief's son in the instance mentioned was burnt to break the drought which had followed his trespass. Among the Vazezuru and the Kalanga, offerings of beer and porridge are made to the ancestors under a large tree. Among the Amandebele and others, the use of any timber or fuel of the *citamuzi*, the "tree of discord", is forbidden. It is used at funerals as a symbol of farewell greeting.

Mollusca of the John Murray Expedition

Two recent monographs deal with the Opisthobranchs and Pteropods ("A Systematic and Anatomical Account of the Opisthobranchia" by N. B. Eales, British Museum (Natural History). The John Murray Expedition 1933–34 Scientific Reports, **5**, No. 4. Pteropoda by H. G. Stubbings, **5**, No. 2; 1938). Dr. Eales's work on the Opisthobranchs is most excellent and is a valuable addition to our knowledge of the group, although the specimens available are somewhat scrappy and possibly not altogether representative of the region. She has studied specially the nervous and reproductive systems with the alimentary system in less detail. This will go far in elucidating the relationships of the various genera, especially so because they are illustrated with very carefully drawn figures. Notes on the feeding of two species, *Hydatina* (*Aplustrum*) *velum* and *Hexabranchus sanguineus*, are interesting. In the Hydatina the alimentary canal is remarkably long and the thin-walled crop fills the greater part of the body cavity. In the crop was found a cirratulid worm, 80 mm. long and 4 mm. wide, more than four times as long as the Hydatina itself. Bergh noted a similar worm in this species which must select its food. In *Hexabranchus sanguineus* the crop was full of Foraminifera, worm tubes and pieces of gastropods and echinoderms which fully account for the very much worn radula. A comparison of the chief types represented provides a series exhibiting progressive concentration of the nervous system, the least specialized being *Bulla ampulla*, the most specialized *Hexabranchus sanguineus*. The collection of Pteropods is small. All are known forms and none occur in large numbers. Mr. Stubbings has attempted to show the vertical distribution of certain species and his notes are interesting and suggestive.

Hawaiian Bivalves

THE recent work by William Healy Dall, Paul Bartsch and Harald Alfred Rehder entitled "A Manual of the Recent and Fossil Marine Pelecypod Mollusks of the Hawaiian Islands" (*Bull. Bernice P. Bishop Museum*, 153; 1938) is a comprehensive account of Hawaiian Pelecypoda, including a very large number of species. It is purely conchological, dealing only with the shells and not the animals, but will be indispensable as a work of reference. The main part is based on the valuable collection of Mr. D. Thaanum presented to the United States National Museum, but added to this are specimens from collections, chiefly from deeper waters, made by the U.S. Bureau of Fisheries steamer *Albatross* in Hawaiian waters, and smaller collections made by individual workers.

Paul Bartsch, in his introduction, is inclined to attribute the Pelecypod fauna of the Hawaiian Islands mainly to drift. The fauna is composed, with few exceptions, "of just such species and such only, as might use this type of transportation". The work is illustrated by fifty-eight good photographic plates.

Powdery Mildew of the Rose

THE fungus *Sphærotheca pannosa* var. *rosæ* causes the powdery mildew disease of roses, and is the most serious parasite of this national flower. Control of the malady, however, has often been difficult, owing to lack of exact knowledge of the factors which affect the development and distribution of the disease. Karla Longrée has recently investigated this question (Cornell Univ. Agr. Exp. Sta. Memoir 223, Ithaca, N.Y., U.S.A., April 1939). The effect of external conditions upon the propagation of the fungus appears sufficiently limited to account for the sporadic nature of the malady. Optimum temperatures for spore germination, for example, fall rapidly from 27·5° to 21° C. during the first few days after liberation. Sporulation only takes place between 9° and 27·5° C., and spores quickly lose their viability. Relative humidity of the atmosphere, however, provides an even greater obstacle to spore germination, which was only good between the narrow limits of 97 and 99 per cent humidity. Young rose leaves, however, appear to have a layer of air with such a high relative humidity, close to the surface, particularly on the underside, and so are prone to attack by the fungus. Many other details of the effect of climatic environment upon the fungus are given in the paper, which should provide a valuable basis for the more efficient control of the malady.

The Daruma Volcano, Japan

HISASHI KUNO has recently made a study of this volcano (*Bull. Earthq. Res. Inst., Tokyo*, **16** (4), 763–771; 1938) and finds that it may best be classed as a shield volcano of the Hawaiian type similar to the Prospect Peak and Mount Harkness volcanoes of the Lassen Volcanic National Park as have been described by Howel Williams. It has a breached central crater and a gently sloping flank, having been built up chiefly by repeated gentle outpourings of lavas with scarcely any violent explosive eruption. Each lava was accompanied by large blocks formed by the breaking down of the already consolidated scoriaceous crusts. The composition of these lavas did not change much from one effusion to another, being mostly hypersthene-augite-andesite, becoming only slightly richer in olivine towards the later stage of activity. Augite-olivine-basaltic andesite and olivine-basalt were also erupted occasionally during the later stage. A comparison of the extent to which the volcano has been dissected, with that of the other north Izu volcanoes, suggests that it is of older Pleistocene age or slightly older, though no decisive conclusion can be drawn.

The Atomic Weight of Hydrogen

ON the basis of a protium-deuterium (H/D) ratio in normal water of 5000, the International Committee on Atomic Weights in 1938 changed the accepted atomic weight of hydrogen from 1·0078 to 1·0081. No reference to the source of this ratio was given and the higher ratios 6900 and 6500 found by Gabbard and Dole and by Hall and Jones respectively, were not mentioned. J. A. Swartout and M. Dole (*J. Amer. Chem. Soc.*, **61**, 2025; 1939) have confirmed the ratio 6900 by a new exchange reaction $H_2 + HOD \rightleftarrows HD + HOH$ and also reinvestigated the density of water made from atmospheric oxygen as compared with normal water, as the published data vary from 6·0 to 8·6 parts per million excess density as compared with normal water. Lake Michigan water was used and water made from the oxygen of this water and pure protium had a density 15·5 p.p.m. smaller than normal Lake Michigan water, giving a ratio H/D = 6970. Water containing normal Atlantic Ocean oxygen and pure protium was 15·7 p.p.m. lighter than normal Atlantic Ocean water, giving a ratio H/D = 6900. Deuterium-free hydrogen was burned with atmospheric oxygen and the density of the water produced compared with that of water containing normal Lake Michigan oxygen and pure protium, and the atmospheric oxygen water was 6·6 p.p.m. heavier, which corresponds with a greater atomic weight of oxygen in air of 0·000119 ± 0·00002 atomic weight units. The chemical atomic weight of hydrogen calculated from the new H/D ratio is found to be 1·0080 instead of the value of 1·0081 recently adopted by the International Committee.

Fluctuation Voltages

IT has been known for a long time that there is a spontaneous oscillating potential difference between the ends of an isolated resistance. This is generally attributed to thermal agitation of the free electrons. It is known to have an effective value which is proportional to the resistance and to its absolute temperature. In a paper by F. C. Williams (*J. Inst. Elec. Eng.*, Aug.), various methods are given of representing the voltage, current, etc., of the thermal fluctuations both in simple and in complex networks. The oscillations are augmented if the resistance, whether an open or a closed circuit, carries a current which has passed through a thermionic valve. The two components of oscillation are called thermal and thermionic fluctuation voltages respectively. All electrical communications suffer from them, as they always form an inevitable background which ruins intelligibility when the strength of the signal is less than some definite amount, which is independent of subsequent amplification and magnifies both alike. It is important to be able to predict the fluctuation voltage inherent in any assembly of circuits and thermionic valves. Although there has been considerable research in this direction the exact mechanism of these effects has not yet been discovered, and it is very laborious to estimate their probable magnitude in complex circuits. The author recently described a method of representing the phenomena which enables the fluctuation generated in any specified network to be computed by the ordinary processes of circuit analysis, by ignoring the physical mechanism which produces the effects. The author states that extensive experiments have completely vindicated this method of representation. In this representation the distribution of potential developed along the length of a resistance is simulated, for simplicity, by a concentrated generator producing a specified E.M.F. and supposed inseparable from the resistance; an analogous representation is adopted for thermionic fluctuations. This method, which is useful in technological applications, is called 'voltage representation'. An alternative method, which is termed 'current representation', is sometimes more convenient. Both methods are described in this paper.

HEALTH AND SAFETY IN INDUSTRY

THE annual report of the Chief Inspector of Factories for 1938 gives an encouraging picture of the way in which health and safety in industry in Great Britain are being improved. Although the report deals only with the first six months during which the Factory Act of 1937 was in force, it indicates that great progress has been made in applying the new code and raising the standard of all factories and workshops to the level of the best. Indeed, a striking feature of the coming into operation of the Act, the report points out, has been the co-operation of employers, whose inquiries have been directed to the best manner of doing this or that, rather than to the necessity of doing it. Accordingly, the factory inspector is now regarded more as an expert adviser on problems of health and safety and less as an official with punitive powers.

In regard to safety, the new Act marked an extension of safety regulations to diminish accidents. The report shows that in 1938 the number of reportable accidents was 7 per cent less than in 1937, while fatal accidents were reduced by 6 per cent. While, however, these figures remain at the high level of 180, 103 and 944 respectively, there is still plenty of room for improvement in this respect, and the fall in accidents must be attributed to some extent to the reduction of the number of people in employment in consequence of the trade depression. In this connexion, the chief inspector pointed out that the decrease was especially marked among the fatal accidents on factory premises, and considered that the new safety requirements are already beginning to take effect. It should, of course, be remembered that the relative value of the accident figures for 1938 is affected by the wider requirements in the new Act for reporting accidents.

An important factor in the prevention of accidents is the work of the Safety Committees and safety officers throughout the country, particularly in the larger factories. In such work, scientific workers have an important part to play. Success in this matter depends largely on their technical knowledge and interest, and their skill in enlisting the co-operation of fellow-workers who may not possess such expert knowledge. Moreover, significantly enough, the report points out, special difficulty is often experienced in small factories, for example, in the elimination of fire risk through effective protection of circuits from persistent earth leakage, because neither the instruments required nor the ability to use them are available.

If, therefore, the report contains welcome evidence that the management side is increasingly alive to its responsibilities in this matter, it once more endorses the far-sightedness of the policy of such professional associations as the British Association of Chemists in attempting to secure that certain specified operations are carried out under the direct supervision of properly qualified persons. This is indeed essential in the development of new processes, and the value of such a safeguard tends to increase as the pressure due to national defence requirements increases. From the point of view of safety, no less than health, the reduction of hours of work is a wise and beneficial measure.

Once again an important section of the report is concerned with accidents to young workers. A most serious problem in factories to-day is indeed to protect young workers from the alarming proportion of accidents occurring in the age group 14–18, which are often due to carelessness, ignorance or lack of discipline. The education authorities are now endeavouring to prepare boys and girls for the risks of their future employment by giving such training as they can to the young people while they are still attending colleges or schools. Progress in this matter obviously depends on close co-operation with employers themselves. The report points out that the firms which are most successful in reducing accidents to young workers are those which regard their employees both from the personal point of view and that of their future value as skilled workers. Moreover, if the number of accidents is to be reduced as far as possible, the training and supervision of the young entrants into industry must be extended beyond their instruction with regard to the use of machinery, for most of the injuries due to accidents come from other causes.

At the present time there is a further factor in the shortage of young workers, which may tend to increase this already alarming incidence of accidents among young workers. Due to this shortage there may be greater danger that boys and girls may be placed in positions for which they are not most suitable. If it is a counsel of perfection at the present time to select boys and girls who are the most suitable mentally and physically for the work which has to be done, at least greater care could be taken to prevent those specially prone to accidents from being placed in the more hazardous posts. Moreover, the fact that accidents tend to occur to particular boys and girls whom the management consider to be among the smartest and most intelligent in the works is a further demonstration of the need of close guidance and supervision if only to maintain discipline, to remedy lack of experience, for example, as to the type of clothing worn, and prevent dangerous experiments on the part of young workers due to their inquisitiveness and eagerness to try out ideas of their own.

While, therefore, the evidence presented in this report shows that the great developments in organized attempts to reduce accidents in recent years are gradually achieving their object, there can be no reasonable room for doubt that great efforts still continue to be required in this field, and notably in attention to the young workers. The field of research open to the Industrial Health Research Board remains a wide one, and it is significant that special attention is directed to this matter in the programme recently formulated by the Scientific Advisory Committee of the Trades Union Congress. At its first meeting this committee agreed that the subjects upon which the committee might be consulted in regard to their effect on labour and social conditions should include the position of research in relation to

industrial and occupational diseases with a view to prevention rather than cure, and also researches into industrial fatigue and nerve strain, including systems of labour measurement in relation to shorter working hours, holidays and minimum periods for rest and recreation. Two sub-committees have been formed to give their attention to these subjects and a third sub-committee to deal with the effects of new industries, new materials, new uses of new processes, upon the distribution, displacement and character of labour with particular reference to plastics, textiles and non-textile products.

In view of the increasing responsibilities which scientific workers must assume for control and management in industry, the report of the Chief Inspector of Factories is a timely reminder to them of their opportunities and responsibilities in this important field.

FISHERY RESEARCH IN SCOTLAND

THE passing of the Fishery Board for Scotland, under the Reorganisation of Offices (Scotland) Act, means the removal of a landmark from the field of fishery research. As the Development Commissioners observe in their latest annual report, the Board was the first department of Government in the United Kingdom to possess a permanent scientific organization, and its scientific staff was responsible for many of the earlier classical discoveries in marine research, while in more recent years it has made important contributions to the development of fishery science.

Since its inception, the Board has had its headquarters in Edinburgh, one of the homes of the modern science of oceanography. From Edinburgh, Edward Forbes conducted much of his pioneer work of shallow-water dredging and Dr. Bruce his polar researches, and the city is for ever to be associated with the famous *Challenger* expedition and the names of those deep-sea explorers, Sir Wyville Thomson and Sir John Murray. The last-named was scientific member of the Fishery Board and the chief British delegate at the International Congress held at Stockholm in 1899—a congress which led to the formation of the International Council for the Exploration of the Sea.

It would probably amaze some of these pioneer fishery investigators to see how far governmental interest in research, land and marine, has progressed since their time. There are many to-day who, like Forbes, would prefer to see scientific research conducted without the trammels of officialdom; but finance is a hard taskmaster and has a way of assuming the direction and control of policy. Certainly, without Government funds the conduct of marine research would, in view of the costly equipment and staff required, be a difficult undertaking for private enterprise.

It was in 1882, following a report by a Select Committee of the House of Commons, which was impressed by the progress of fishery research in the United States, that the Fishery Board for Scotland was empowered to carry on scientific researches. The funds provided were on a modest scale, but the Board was enabled in 1886 to acquire a small steam research vessel, the *Garland*, which was employed mainly in investigating the effects of trawling on the inshore fisheries. With the great development of trawling, this question had become one of much public and political interest, especially in Scotland, where the inshore fisheries are of considerable importance. The investigations are described in Prof. W. C. McIntosh's "Resources of the Sea", in which the author did not support the Board in the policy of restriction of trawling on which it decided.

In 1895 the Board was reconstituted, and "a person of skill in the branches of science concerned with the habits and food of fishes" was thenceforward included as one of its members. The role was filled in turn by such distinguished men of science as Prof. Cossar Ewart, Prof. W. C. McIntosh and Sir John Murray, and since 1898 the scientific member of the Board has been Sir D'Arcy W. Thompson, who has taken so long and honourable a part not only in fishery science but also in many other fields of culture and education.

The establishment in 1902 of the International Council for the Exploration of the Sea gave a great fillip to marine research, and the share of the programme of international research assigned to Great Britain was entrusted, so far as the northern half of the North Sea was concerned, to the Fishery Board for Scotland acting as agent for the Treasury. The work in the southern half of the North Sea was undertaken originally by the Marine Biological Association and afterwards, in 1910, by the Board (now Ministry) of Agriculture and Fisheries.

A new research vessel, the *Goldseeker*, was provided for the Fishery Board in 1902, and she was replaced in 1920, by means of a grant from the Development Fund, by the research vessel *Explorer*, which is still in commission.

Laboratories were set up at Dunbar, Granton and Tarbert (Loch Fyne) and finally at Aberdeen, where the Board's scientific staff is now stationed. The Board has been fortunate in securing the services of a succession of scientific superintendents of outstanding ability, of whom Fulton and Bowman may be specially mentioned. Apart from his varied contributions to fishery science, Fulton found time to write the "Sovereignty of the Sea", a valuable historical survey of questions of maritime jurisdiction, while Bowman laid the foundation for the forecasts which have now become possible of the stocks of haddock in the sea.

The statistical records of the Board are of the greatest value. Sir D'Arcy Thompson is personally responsible for a series of statistical reports on the fisheries of the North Sea, which are indispensable to any proper study and appreciation of fishery problems.

In conclusion, it is fitting to mention the contributions made by the Board to salmon and freshwater fishery research. The names of Archer, Young, Calderwood and Menzies, in turn inspectors of salmon fisheries, stand high as authorities in this branch of science.

H. J. C.

SCIENCE NEWS A CENTURY AGO

Propagation of Heat in Liquids

ON September 14, 1839, the *Athenæum* said: "The experiment of M. Despretz concerning the propagation of heat in liquids has been attended with the most satisfactory results. From these it appears that a liquid column being heated at the upper part, the heat is propagated according to the same laws as those belonging to solid bodies; that the temperature decreases from the axis to the surface, and from the surface to the wall of the side. The depth to which solar heat penetrates in a given time may be easily calculated by these data in large lakes and isolated seas". The French physicist César Mansuète Despretz, well-known for his studies of heat, was born in 1792 and died on March 15, 1863.

Scientific Gossip

ON the same page in the *Athenæum* as the above note appeared, was a column of 'Weekly Gossip' in which it was said: "The prevailing quiet at home has induced us to hunt over the foreign papers and journals, in the hope that something might be thence gleaned, but all seem subject to the same summer influences. It may be well, however, to remind our scientific friends that . . . the Italian savants are to assemble at Pisa in October; that the French Geologists meet in the same month; and that the German Naturalists meet this year at Pyrmont. An account appears in the *Nördische Blätter* of an immense landslip at Federowka, a village situated on the Volga . . . The motion of the ground continued with more or less violence, for nearly three days, and seventy houses were either wholly or partially destroyed. . . . On one side of the village rise high hills, the upper strata of which are of limestone, but the lower of various kinds of clay, while on the opposite side it is washed by the Volga, which is here hemmed into a narrow bed; and the waters thus confined are supposed to have forced a passage between the stony and alluvial beds.

Proposed Society for Practical Mechanics and Chemistry

THE *Mechanic and Chemist* of September 14, 1839, published a note from "Tyro Chemicus" saying: "The increasing desire which the middle classes evince for information in every department of science, particularly those branches in which mechanics and chemistry form a part, shows the immediate necessity of all students in the above branches of science combining together and forming themselves into a society in which practical mechanics and chemistry are exclusively studied, and affording them benefits which the Mechanics' Institution and other similar institutions have denied them; for although they may be called mechanics' institutions, etc., yet no person will attempt to deny that practical mechanics is in most of them totally excluded. . . ." The same remark applied to practical chemistry, and the Editor of the *Mechanic and Chemist* in recommending the proposal said: "Another important advantage derived from a society of this description is the reciprocal instruction resulting from the intercourse of the numbers. Many difficulties may arise to a practical man which would sooner and more satisfactorily be disposed of by a jury of workmen, than by all the erudition of the Royal Society".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AGRICULTURAL CHEMIST at the School of Agriculture, Houghall, Durham—The Director of Agriculture, 23 Old Elvet, Durham (September 14).

TEACHER OF MINING SUBJECTS in the Whitwood Mining and Technical Institute—The Secretary to the Managers, Education Offices, Castleford, Yorks (September 15).

RESEARCH ASSISTANT IN PHYSICS—The Registrar, University, Leeds 2 (September 20).

PROFESSOR OF CHEMISTRY—The Registrar, Indian Institute of Science, Bangalore, India (October 31).

PROFESSOR OF BIOCHEMISTRY—The Registrar, Indian Institute of Science, Bangalore, India—(October 31).

ASSISTANT for the Department of the Advisory Economist—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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